BULLETIN No. 380 DECEMBER, 1935

The Maine Agricultural Experiment Station

ORONO

Summary Report of Progress, 1935

SOME PASTURE LANDS ARE PLOWABLE, WELL-FERTILIZED, AND PROSPEROUS

FINANCIAL STATEMENT
For the Fiscal Year Ending
June 30, 1935

UNIVERSITY OF MAINE
THE MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

IMPERIAL ENTOMOLOGICAL
8 JUNE 1936
INSTITUTE

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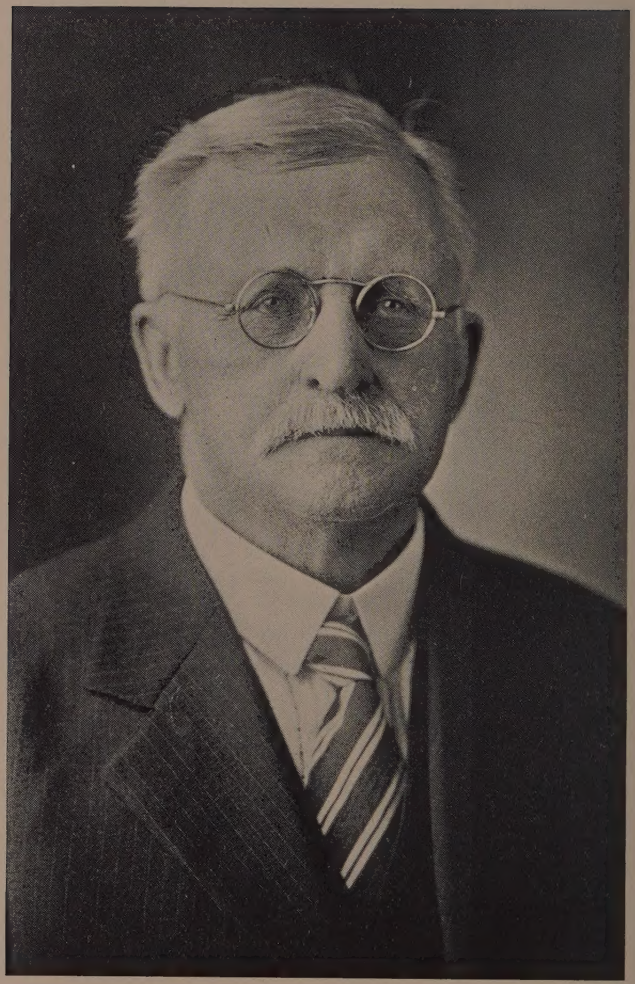

James Monroe Bartlett

JAMES MONROE BARTLETT

It was in the summer of 1902 that the writer first met James Monroe Bartlett and it was in the fall of 1934 that I saw him for the last time. For nearly sixteen years following our first meeting he was my chief and, although a like period and more has elapsed since my connection with the Maine Agricultural Experiment Station, his passing has left a vacancy and a sadness that other friends can never fill and time can never quite dispel.

His boyhood was spent on a farm in Litchfield, Maine, where he was born September 25, 1856. After attending the Academy in his native town he entered the Maine State College, in 1876, and was graduated four years later with the degree of B.S. in Chemistry. Following graduate work at Cornell University he received his Master's Degree from Maine in 1883 and accepted a position as Assistant Chemist at Pennsylvania State College, where he remained two years.

On May 1, 1885, he returned to his native state as a member of the staff of the Maine Fertilizer Control and Agricultural Experiment Station, first as Assistant Chemist and soon as Chief Chemist, which latter position he held until his death, May 11, 1935. His wife, who survives him, was Sarah Caroline Pattangall, sister of the former Chief Justice William R. Pattangall. He is also survived by two sons, three daughters, and seven grandchildren.

For a full half century he conducted research problems, supervised inspection control analyses, and gave freely to all who asked from his store of information on the varied agricultural problems of the state.

No one could be associated long with Dr. Bartlett without coming to have for him keen admiration, sincere respect, and real love. Unassuming almost to a fault, the casual acquaintance would hardly suspect that back of the quiet exterior was a fund of expert knowledge, general information, and dry humor that few possess. Those who worked with him in the laboratory were early impressed with two characteristics. Thorough grounding in the fundamentals of analytical chemistry coupled with rare patience and ingenuity enabled him not only to arrive at correct methods of solution when

problems were presented but to construct the necessary apparatus for conducting any new and unusual work; and any professional information or knowledge which he possessed was always freely given to those who worked under his direction.

His judgment was never hasty and was almost invariably sound. He was a keen observer, was careful and thorough in his work, and in the interpretation of the results of a complicated analysis his conclusions were usually correct. His advice, sought continually on the most divergent topics, was always practical and has had wide influence on the agriculture of the state. The digestion experiments which he conducted with sheep, steers and poultry added materially to the knowledge of farm feeding; his investigation of the adaptability of potato varieties in Aroostook County and the methods of planting, spraying, and dusting of this important crop was instrumental in increasing materially the potato production of this section. Compared with many workers of this period he published little research under his own name for he never courted publicity or sought fame, but during the fifty years of his service many of the bulletins and reports of the Station contained valuable results of his painstaking work.

Dr. Bartlett was an active member of the Association of Official Agricultural Chemists from 1891 until his death and during this time acted as reporter upon nitrogen, referee upon dairy products, and associate referee upon tea and coffee. He often collaborated with other referees and assisted in improving many proposed methods of analysis. He was a member of the Executive Committee in 1910 and at various times served on other committees. His most conspicuous work for the Association was the formulating of a practical and accurate method, which was adopted as official, for determining borax in fertilizers at a time when some of the domestic supplies of potash were contaminated with this impurity. He attended the Semi-Centennial Anniversary of the Association in Washington in 1934 and, as one of the oldest and most prominent members present, was seated at the speakers' table at the banquet. Many of his associates who met him there for the last time will long retain the memory of his genial personality.

On two occasions Dr. Bartlett served as Acting Director of the Experiment Station and was offered the post of Director. This position he declined, preferring to remain as Chemist rather than

to take on new responsibilities at a time of life when he felt that he should be relinquishing rather than assuming new duties.

In 1927 the University of Maine conferred upon him the Honorary Degree of Doctor of Science as "a loyal son of the State of Maine, contributor to the scientific advancement of agriculture, and contributor to important methods of analysis of the Official Agricultural Chemists Association."

Dr. Bartlett was a member of the American Chemical Society and the Phi Gamma Delta fraternity. He was an ardent sportsman and his vacations were usually taken in the woods with dog and gun or on some favorite trout stream and on these excursions he was a delightful companion as the writer can testify from many happy memories.

With his death the community has lost a loved neighbor, the state a valued citizen, and his professional associates throughout the country an honored co-worker.

Herman H. Hanson*

* State Chemist for the Delaware State Board of Agriculture and formerly Associate Chemist at the Maine Agricultural Experiment Station.

INTRODUCTION

The progress of the research of the Station for the calendar year 1935 is reported briefly in this bulletin. Rarely are definite conclusions warranted with the results of only one year on a study as a basis. Frequently, the results of ten or fifteen years are required as a basis for a clear analysis of a problem under investigation. Particularly is this true with studies in which such variables as soil and climate enter either directly or indirectly. For the convenience of those interested in particular phases of the research, the arrangement is by subject matter headings.

POTATOES

An Economic Study of the Potato Industry in Maine. William E. Schrumpf. Under this general heading there is under way at present a study of the costs and returns in producing potatoes in Maine and a study of motive power on Maine potato farms.

Costs and Returns in Producing Potatoes in Maine. The material for this study was obtained in Aroostook County and in the vicinity of Dover-Foxcroft in central Maine. It covers the production and disposal of the potato crops grown on 165 farms in 1928, 1929, and 1930 in Aroostook County and on 38 farms in 1929 and 1930 in central Maine. Four groups of farms are represented, three groups in Aroostook County and one group in central Maine. The three groups in Aroostook County include 101 farms producing table-stock potatoes in the area near Presque Isle, 43 farms in the area near Houlton also producing table-stock, and 21 farms in both areas producing primarily certified-seed potatoes. The 38 farms in the central Maine group produced table-stock potatoes.

Potatoes held a relatively favorable position for the three-year period, 1928-1930, for which their average purchasing power was approximately 103. This compares with the average purchasing power of 63 for the four-year period 1931-1934.

Tentative costs and returns have been compiled for these areas for each of the years involved. A summary of the yearly average costs and returns in producing potatoes in these four groups of farms follows:

Presque Isle Area. Of the yearly average production of 116.8 barrels of potatoes per acre on the 101 table-stock farms in the Presque Isle area, 100 barrels were sold and 8 barrels were used on the farm. The remainder is accounted for by shrinkage in storage and by culls dumped. The value of the 108 barrels utilized was $214.95. The average cost of growing, harvesting, storing, and selling the crop was $171.32 per acre. Of this amount 62.7 per cent was for growing, 11.4 per cent for harvesting, 18.9 per cent for storing, and 7.0 per cent for selling. Selling refers to the disposal of potatoes at local shipping points.

The net returns were $43.63 per acre or 37 cents per barrel of potatoes produced. Man labor expended was 79.0 hours per acre. The cost of man labor was $35.35 per acre of potatoes. The return for man labor was $78.98 per acre of potatoes or $1.00 per hour. The average acreage of potatoes in this area was 43 acres per farm (Table 1).

TABLE 1

Summary of Costs and Returns in Producing Table-Stock Potatoes on 101 Potato Farms in the Presque Isle Area of Aroostook County, Maine: Average of the 3 Years, 1928-1929-1930

	Average per farm	Average per acre of potatoes	
		Amount	Value
	dollars		dollars
Returns:			
Potatoes sold	8,787	100 barrels	204.35
Potatoes used on farm	456	8 barrels	10.60
Total	9,243	108 barrels	214.95
Costs:			
Growing	4,616		107.35
Harvesting	842		19.58
Storing	1,392		32.37
Selling	517		12.02
Total	7,367		171.32
Net returns	1,876		43.63
Man labor cost	1,524	79.0 hours	35.35
Cost of land use	342		7.95
Returns for man labor	3,400		78.98
Returns for use of land	2,218		51.58
Value of crop land	5,427		126.21
Returns per hour of man labor	$1.00		
Returns per barrel of potatoes produced	37 cents		
Acres of potatoes per farm	43 acres		
Yield of potatoes per acre	116.8 barrels		

Houlton Area. For each acre of potatoes on the 43 farms producing table stock in the Houlton area an average of 91 barrels of potatoes was sold and 9 barrels was used on the farm. The average yield of potatoes in this area was 106.3 barrels per acre. The value of the potatoes sold and used was $198.33. The cost of growing, harvesting, storing, and selling the crop was $166.33 per acre. The net returns were $32.00 per acre of potatoes produced or 30 cents per barrel. The cost of the 88.2 hours of man labor required per acre was $35.65. The return for man labor was $67.65 per acre or 77 cents per hour. The potato acreage averaged 30 acres per farm (Table 2).

Compared with the Presque Isle area, potato production in the Houlton area cost $4.99 less per acre but also returned $16.62 less per acre. The net returns in the Houlton area were $11.63 less per acre than in the Presque Isle area.

TABLE 2

Summary of Costs and Returns in Producing Table-Stock Potatoes on 43 Potato Farms in the Houlton Area of Aroostook County, Maine: Average of the 3 Years, 1928-1929-1930

	Average per farm	Average per acre of potatoes	
		Amount	Value
	dollars		dollars
Returns:			
Potatoes sold	5,611	91 barrels	187.03
Potatoes used on farm	339	9 barrels	11.30
Total	5,950	100 barrels	198.33
Costs:			
Growing	3,330		111.00
Harvesting	577		19.23
Storing	724		24.13
Selling	359		11.97
Total	4,990		166.33
Net returns	960		32.00
Man labor cost	1,083	88.2 hours	35.65
Cost of land use	159		5.30
Returns for man labor	2,043		67.65
Returns for use of land	1,119		37.30
Value of crop land	2,436		81.20
Returns per hour of man labor	77 cents		
Returns per barrel of potatoes produced	30 cents		
Acres of potatoes per farm	30 acres		
Yield of potatoes per acre	106.3 barrels		

Certified-Seed-Potato Farms. Of the 127.5 barrels of potatoes produced per acre on the 21 certified-seed-potato farms, 119 barrels were utilized, 111 barrels being sold and 8 barrels used on the farm. These 119 barrels of potatoes were valued at $272.13. The costs of growing, harvesting, storing, and selling came to $209.00 per acre. The net returns were $63.13 per acre or 50 cents per barrel of potatoes produced. The 98.1 hours of man labor required per acre cost $44.01. The return for man labor was $107.14 per acre of potatoes or $1.09 per hour. The average acreage of potatoes on these farms was 52 acres of which 31 acres were certified (Table 3).

TABLE 3

Summary of Costs and Returns in Producing Potatoes on 21 Farms Growing Certified Seed in Aroostook County, Maine: Average of the 3 Years, 1928-1929-1930

	Average per farm	Average per acre of potatoes	
		Amount	Value
	dollars		dollars
Returns:			
Potatoes sold	13,553	111 barrels	260.63
Potatoes used on farm	598	8 barrels	11.50
Total	14,151	119 barrels	272.13
Costs:			
Growing	6,439		123.83
Harvesting	1,087		20.90
Storing	2,221		42.71
Selling	1,121		21.56
Total	10,868		209.00
Net returns	3,283		63.13
Man labor cost	2,281	98.1 hours	44.01
Cost of land use	486		9.35
Returns for man labor	5,564		107.14
Returns for use of land	3,769		72.48
Value of crop land	7,425		142.79
Returns per hour of man labor	$1.09		
Returns per barrel of potatoes produced	50 cents		
Acres of potatoes per farm	52 acres		
Acres of potatoes certified per farm	31 acres		
Yield of potatoes per acre	127.5 barrels		

Compared with the table-stock farms of the Presque Isle area, the costs on the certified seed farms were $37.68 more per acre.

The returns, however, were $57.18 more, and the net returns $19.50 more.

Central Maine Area. The average yield of potatoes for the two years, 1929-1930, included in the study of the central Maine area was 96.2 barrels per acre. Of this amount 91 barrels were utilized, 83 barrels being sold and 8 barrels used on the farm. The value of the 91 barrels was $225.36. The growing, harvesting, storing, and selling costs amounted to $160.40. The average net returns were $64.96 per acre or 68 cents per barrel. The potato acreage of the central Maine area averaged 25 acres per farm (Table 4).

TABLE 4

Summary of Costs and Returns in Producing Table-Stock Potatoes on 38 Potato Farms in the Central Maine Area: Average of the 2 Years, 1929-1930

	Average per farm	Average per acre of potatoes	
		Amount	Value
	dollars		dollars
Returns:			
Potatoes sold	5,348	83 barrels	213.92
Potatoes used on farm	286	8 barrels	11.44
Total	5,634	91 barrels	225.36
Costs:			
Growing	2,760		110.40
Harvesting	441		17.64
Storing	601		24.04
Selling	208		8.32
Total	4,010		160.40
Net returns	1,624		64.96
Man labor cost	766	82.0 hours	30.72
Cost of land use	63		2.52
Returns for man labor	2,390		95.68
Returns for use of land	1,687		67.48
Value of crop land	979		39.16
Returns per hour of man labor	$1.17		
Returns per barrel of potatoes produced	68 cents		
Acres of potatoes per farm	25 acres		
Yield of potatoes per acre	96.2 barrels		

Compared with the farms of the Presque Isle area for the same two years, 1929-1930, the costs on the central Maine farms averaged $17.72 less per acre. The returns, however, were $46.66 less and the net returns $28.94 less.

FIG. 26. A study is being made of the possibilities of using boxes for picking and storage of potatoes. The potatoes are stored in the same boxes in which they are picked, thus eliminating considerable handling incident to bulk storage.

MOTIVE POWER ON MAINE POTATO FARMS. The material for this study was obtained in Aroostook County and in the central Maine area in the vicinity of Dover-Foxcroft. Information was secured on 160 farms in Aroostook County covering the crop year 1933, and on 90 farms in the central Maine area covering the crop year 1934.

The information covering the crop year 1933 in Aroostook County has been partially analyzed. The material obtained in central Maine covering the 1934 crop year has been checked and is being tabulated. The following is preliminary information on the cost of maintaining horses and tractors in Aroostook County.

TABLE 5

Motive Power on 160 Aroostook County Potato Farms in 1933; Number and Value of Horses and Tractors

Item	Number	Value	Value per farm
Horses	578	$110,693	$931
General-purpose tractors	85	46,840	293
Standard tractors	64	19,880	124

Number and Value of Horses and Tractors. There were in 1933 on the 160 Aroostook County potato farms, 578 horses, 85 general-purpose tractors, and 64 standard tractors. The value of the horses per farm was $931, of general-purpose tractors $293, and of standard tractors $124 (Table 5).

Cost of Maintaining a Work Horse. The average cost per year of maintaining a work horse was $179.24. Credit for appreciation and manure amounted to $15.99, making the net cost $163.25. The three largest items of cost were hay, grain, and man labor doing chores. About 17 per cent of the cost was for hay, 28 per cent for grain, and 20 per cent for labor (Table 6).

TABLE 6

Motive Power on 160 Aroostook County Potato Farms in 1933; Cost Per Year of Maintaining a Work Horse

Item	Amount	Cost	Per cent of cost
Hay	3.4 tons	$ 30.42	16.97
Oats	141.0 bushels	50.98	28.44
Bedding	1.7 tons	5.81	3.24
Repair of harness		5.53	3.09
Shoeing		12.21	6.81
Veterinarian		2.06	1.15
Labor	20.1 days	35.69	19.91
Depreciation		11.22	6.26
Interest		9.55	5.33
Housing		11.10	6.19
Taxes		4.67	2.61
Total cost		$179.24	100.00
Credit: appreciation and manure		$ 15.99	
Net cost		163.25	
Cost to potatoes		123.98	
Average value per horse		191.51	
Acres of potatoes per horse		12.8 acres	

Cost of Maintaining a General-Purpose Tractor. The three largest items of cost in maintaining a general-purpose tractor were fuel (gasoline and kerosene), depreciation, and interest. Of the yearly cost of $225.91 per tractor, about 35 per cent was for gasoline and kerosene, 30 per cent for depreciation, and 11 per cent for interest on the money invested in the tractor (Table 7).

TABLE 7

Motive Power on 160 Aroostook County Potato Farms in 1933; Cost Per Year of Maintaining a General-Purpose Tractor

Item	Amount	Cost	Per cent of cost
Gasoline	489.8 gals.	$ 67.67	26.44
Kerosene	190.1 gals.	22.62	8.84
Oil	21.5 gals.	15.62	6.10
Grease	15.2 bbls.	2.35	.92
Labor servicing tractor		2.73	1.07
Repairs		16.00	6.25
Depreciation		77.41	30.25
Interest		27.68	10.82
Housing		10.93	4.27
Taxes		12.90	5.04
Total cost		$255.91	100.00
Average value per tractor		$551.06	
Average number of hours used		311.5 hours	
Cost per hour		$ .82	

Cost of Maintaining a Standard Tractor. The average cost of maintaining a standard tractor was $154.94 per year. As with the general-purpose tractor, the three largest items of cost for the standard tractor, also, were fuel, depreciation, and interest. About 32 per cent of the maintenance cost of the standard tractor was for gasoline and kerosene, 31 per cent for depreciation, and 10 per cent for interest (Table 8).

TABLE 8

Motive Power on 160 Aroostook County Potato Farms in 1933; Cost Per Year of Maintaining a Standard Tractor

Item	Amount	Cost	Per cent of cost
Gasoline	258.7 gals.	$ 44.80	28.92
Kerosene	47.8 gals.	5.70	3.68
Oil	11.8 gals.	9.04	5.83
Grease	7.9 bbls.	2.30	1.48
Labor servicing tractor		.94	.61
Repairs		9.38	6.05
Depreciation		48.05	31.02
Interest		15.40	9.94
Housing		11.39	7.35
Taxes		7.94	5.12
Total cost		$154.94	100.00
Average value per tractor		$310.62	
Average number of hours used		107.5 hours	
Cost per hour		$ 1.44	

Comparison of the Costs of General-Purpose and Standard Tractors. The yearly cost of nearly $256 for maintaining a general-purpose tractor was about 65 per cent larger than the $155 cost for the standard tractor. The general-purpose tractor, however, was used nearly three times as many hours as the standard tractor, 311.5 hours compared with 107.5 hours. Because of the fact that the general-purpose tractor was used more hours than the standard tractor, the cost per hour of use of the former was 43 per cent less than of the latter, 82 cents compared with $1.44.

FERTILIZER EXPERIMENTS WITH POTATOES. *Permanent Plots.* Joseph A. Chucka and Delmar B. Lovejoy. As a result of the relatively dry and hot weather in Aroostook County during the latter half of July and during the entire month of August, the 1935 potato yields on the permanent plots were below normal. The average yield on the check plots (plots receiving 2,000 pounds per acre of a standard 4-8-7 fertilizer) was approximately 84 per cent of the average yield obtained during the previous five years. It was only 75 per cent of the yield obtained on these plots in 1934. However, the relative differences in yield due to varying amounts or kinds of fertilizer were approximately the same as those obtained during recent years. The yields obtained on the two-year rotation series were again considerably higher than those on three-year rotation or on the continuous cropping series. This higher yielding capacity of the two-year rotation series is believed to be due to the larger amounts of organic matter incorporated into the soil on the two-year rotation as compared with either the three-year rotation or the series cropped continuously with potatoes.

Fertilizer Placement Test on Potatoes. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry, and G. A. Cumings, U. S. Bureau of Agricultural Engineering. The data obtained from the 1935 fertilizer placement studies were in general agreement with the results secured in previous years. The placement of fertilizer in bands to the side of the seed pieces at approximately the same level as the seed resulted in larger yields of potatoes than the placement of the fertilizer below the seed pieces or mixing the fertilizer with the soil. The actual differences in yield among the various placements used were smaller than last year. This may perhaps be accounted for by the weather conditions that

prevailed in Aroostook County. The relatively high rainfall shortly after planting tended to minimize any possible fertilizer injury from the poor placements of fertilizer, while the relatively hot and dry weather during the latter part of July and during the month of August stunted the potato crop and tended to prevent the development of yield differences during the latter part of the growing season between good and poor placements of fertilizer.

Potash-Magnesium Test. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry. The comparison of 4-8-3, 4-8-5, 4-8-7, 4-8-10, and 4-8-12 fertilizers both with and without added magnesium was continued on three different farms in Aroostook County. The results obtained indicated only a small response to added magnesium on two farms and a very definite response on the third farm. The response to increasing amounts of potash in the fertilizer was surprisingly small this year. In the series without added magnesium the highest average yield was obtained with the 4-8-7 fertilizer, while in the series with magnesium the 4-8-12 fertilizer produced the highest average yield. As indicated in previous years the response to magnesium was greater in the fertilizers both low and high in potash than it was in the 4-8-7 fertilizer. No information was obtained which would explain the nature of this relationship between magnesium and potash utilization.

Acid Versus Neutral Fertilizer Test on Potatoes. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry. The subject of the residual effect of fertilizers on soil reaction has attracted a great deal of interest during recent years. Much of the experimental work on the problem in other states indicates the desirability of using fertilizers whose residual effect is either neutral or basic in preference to fertilizers which leave an acid residue in the soil. Since neutral and basic fertilizers usually contain some ground limestone in them, there is some question as to whether or not such fertilizers can successfully be used in the production of potatoes over a period of years. Although the amount of ground limestone used per ton of fertilizer is usually small, its concentration in the zone of fertilizer application is relatively great as compared to broadcast applications of

lime. Therefore the use of such fertilizers may result in bringing about a soil reaction, in the zone of fertilizer application, which will be favorable for potato scab development.

Thus far the experimental results indicate that fertilizers neutralized with calcium limestone produce somewhat lower yields of potatoes in Aroostook County than do acid fertilizers. Fertilizers neutralized with dolomitic limestone produce higher yields than acid fertilizers without added magnesium but they produce lower yields than acid fertilizers to which water soluble magnesium has been added. Thus it would appear that the increase obtained from the addition of dolomitic limestone to potato fertilizers under Maine conditions, is due to the magnesium contained in the dolomitic limestone rather than to the neutralization of the residual acidity of the fertilizer.

The foregoing statements are not to be construed as arguments against the use of dolomitic limestone as a liming material in Aroostook County or in any other potato producing area. The soils on many of the potato farms in Maine are too acid for the production of maximum yields of potatoes. Such soils should be limed preferably with dolomitic limestone, but on the basis of present information it would appear preferable to broadcast the necessary amount of lime uniformly over the area and work it in thoroughly rather than to put it into the potato fertilizer and apply it in localized bands within the potato row.

Rate of Fertilizer Application Test on Potatoes. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry. Since all the data on the effect of varying amounts of fertilizer on potato yields were obtained before any information relative to proper fertilizer placement was available, it seems logical to believe that perhaps larger applications of fertilizer might be used if the fertilizer were properly applied. With this thought in mind various rates of fertilizer application were compared with both Irish Cobbler and Green Mountain varieties on three different farms during the past year. Double strength (8-16-14) fertilizer was applied at rates varying from 500 to 1,500 pounds per acre. This fertilizer was applied in narrow bands two inches to each side and slightly below the seed pieces.

Due to the unfavorable growing season the response to increasing amounts of fertilizer was unusually small. Although the highest yield was produced by the heaviest fertilizer application, the increases in yield from applications of 8-16-14 fertilizer greater than 750 pounds per acre were too small to justify the use of the extra fertilizer in 1935. The data, as well as field observations, indicate that water was one of the chief limiting factors in determining potato yield in Aroostook County during the 1935 season.

Uncommon Element Test on Potatoes. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry. The study of the effects of small amounts of manganese, copper, iron, zinc, and nickel in potato fertilizers was continued as carried on during the past three years. This year's data from the test indicate no general beneficial effect due to the use of these elements in potato fertilizers. On one of the two farms upon which this test was located, zinc and iron showed a fairly definite stimulating effect, but on the other farm these same elements showed a depressing effect on the yield of potatoes.

POTATO SPRAYING AND DUSTING. Reiner Bonde. These data were secured from spraying and dusting experiments conducted in 1935 on Aroostook Farm. The work reported here was done with the Green Mountain variety unless indicated otherwise in the text.

General Conditions. The early part of the 1935 season was quite wet. As a result of these moist conditions, late blight or "rust" made its appearance at a very early date. On July 1, rust was reported from Littleton, Maine. An examination of potato fields in that locality revealed that the disease was quite generally distributed and could be found in most of the low-lying fields. The disease was most abundant in the areas bordering the poorly drained places in the fields where the potato vines had been flooded or where water had stood.

Late blight spread also to some extent to the higher land located around the wet and moist places. It is of special interest that the spread of disease was correlated with field cultivation and the spading or horse hoeing operation while the soil was wet. The late blight infection appeared to be spread by the machinery in the process of cultivation and horse hoeing. The disease was most common along the stems and lower leaves that had been partially

covered with moist earth brought in contact with the plants by these farming operations. Observations suggested that the infection was soil borne and later spread by the farming tools. In this connection it is of interest that cultures of the late blight fungus were subjected to the intense cold winter weather of 1934-1935 in Aroostook County and remained viable until the following summer.

The blight had been reported from other parts of Aroostook County by July 15th. Since the disease had thus appeared at an exceptionally early date over a wide territory, the indication during the early part of July was that northern Maine would experience one of the most severe late blight epidemics of its history. Dry weather came, however, at the most critical time and prevented the threatened epidemic. The losses due to late blight were in most cases of little consequence although a few fields were badly defoliated.

Late blight was relatively absent on Aroostook Farm, a fact which rendered some of the experiments on disease control of little value for the 1935 season.

The Value of Spraying Potatoes in the Absence of Late Blight. It is well known that spraying with Bordeaux mixture is a profitable and essential practice during years when late blight is prevalent. It is, however, not so well known to what extent spraying is beneficial in Aroostook County when the disease is absent. The season of 1935 was characterized by the absence of potato blight

TABLE 9

Comparison of Yields from Sprayed and Non-Sprayed Plots in the Absence of Late Blight

Comparison[1]	Yield rate per acre				Difference in favor of spray	
	Sprayed		Not sprayed			
	Bushels	Barrels	Bushels	Barrels	Bushels	Barrels
1	294	107	237	86	57	21
2	283	103	170	62	113	41
3	407	148	362	132	45	16
4	415	151	374	136	41	15
5	401	146	292	106	109	40
Average	360.0	131.0	287.0	104.4	73.0	26.6

[1] These yields were taken from five different series of experiments where sprayed plots were compared directly with unsprayed checks.

on Aroostook Farm so that data pertaining to the value of spraying in the absence of the disease were readily available. Unsprayed and sprayed plots were present in five different fields. The yields for these comparisons are given in Table 9.

The data indicate very clearly that the spraying operation greatly increased the yields in 1935 in spite of the fact that disease was not present to any noticeable extent. The extent of this increase varied for the different plots from 16 to 41 barrels per acre. At an average value of $1.75 per barrel the return for these spraying operations would be from $28 to $71.75 per acre.

The yield increases reported above can be attributed to a large extent to two chief factors. In these tests, insects, particularly flea beetles, were rather abundant and injured the unsprayed plots quite extensively. The other contributing factor was that the season was greatly prolonged and the sprayed plots continued to grow and develop until killed by frost on October 6, whereas the non-sprayed plots were mostly dying or dead before that time.

It is of importance to note that most of the increase in yield made by the sprayed plots occurred after September 10. If a killing frost had occurred about September 15-20, the check or unsprayed plots would have given superior yields. The greatest benefits derived from spraying occur in those seasons when frosts occur late or when late blight is prevalent.

Value of Spraying in Piscataquis County in the Absence of Disease. The value of spraying potatoes in the absence of late blight was demonstrated in Piscataquis County as well as in Aroos-

TABLE 10

Increase in Yield from Spraying in Piscataquis County

Treatment	Yield in barrels per acre	
	Total	U. S. Grade No. 1
Received three applications of Bordeaux after August 19 besides two applications of poison applied earlier in the season	118	103
Controls received no spray after August 19. Two applications of poison earlier in season	81	71
Difference in yield in favor of Bordeaux spray	37	32

took County. This demonstrational plot was conducted near Sangerville under the direction of the local County Agent.

In this test a field of Rust Proof potatoes was left unsprayed until August 19. At that time blight was absent, but flea beetles and leaf hoppers were relatively abundant. The field was sprayed three times with Bordeaux mixture after this date, care being taken to leave a portion of the field unsprayed to serve as a check. The differences secured between the sprayed and unsprayed parts of this field were as indicated in Table 10.

The data available, although not very extensive in nature, indicate that spraying potatoes in the absence of disease may give larger returns in other potato growing regions of the state than in Aroostook County. Insects, especially leaf hoppers, are most abundant in the southern and central portions of Maine and it is quite possible that growers in these regions should adopt an earlier spray schedule than in regions further north where these insects are usually less abundant.

Dusting vs. Spraying. In 1935 a 9 per cent copper lime dust was compared with Bordeaux mixture (10-10-100) as in previous years. The comparative yields for these tests are in Table 11.

TABLE 11

Comparison of Bordeaux Mixture and Copper Lime Dust

Treatment	Yield rate per acre		Increase over control	
	Bushels	Barrels	Bushels	Barrels
Bordeaux mixture 10-10-100	415	151	40	14
Copper lime dust 9 per cent copper	390	142	25	9
Control, not sprayed	375	137	—	—

In these tests the plots sprayed with Bordeaux mixture were superior in general appearance to the dust treated plots and the controls. One should be reminded, however, that in other comparisons made on Aroostook Farm, it was shown that the increases from Bordeaux spraying resulted after September 10 and that if a killing frost had occurred about September 15-20 it is doubtful

if any significant increases in yield would have resulted from either dusting or spraying.

Comparison of Bordeaux Mixture and Basic Copper Sulphate. During the past few years, basic copper sulphate has been sold extensively in Aroostook County as a substitute for Bordeaux mixture for the spraying of potatoes. This commercially prepared product was compared with Bordeaux mixture in a series of replicated spray experiments conducted on Aroostook Farm in 1935. In these comparisons, basic copper sulphate was compared with Bordeaux mixture made with a high-calcium lime and also with a high-magnesium Bordeaux. The Bordeaux was made according to the standard formula, namely, 10-10-100, and the basic copper sulphate was used at the rate of five pounds per 100 gallons of water. The plots received six spray applications. The yields for these comparisons are in Table 12.

TABLE 12

Comparison between Bordeaux and Basic Copper Sulphate

Treatment	Yield rate per acre		Odds in favor of Bordeaux made with dolomitic hydrated lime
	Bushels	Barrels	
Bordeaux made with dolomitic hydrated lime	406	148	------
Bordeaux made with calcium hydrated lime	387	141	22.26 to 1
Basic copper sulphate	390	142	22.26 to 1
Non-sprayed controls	362	132	Very high

The comparison of yields, indicated in Table 12, shows that Bordeaux mixture made with dolomitic lime (high-magnesium hydrated lime) was superior both to basic copper sulphate and to Bordeaux mixture made with calcium lime. (Dolomitic Bordeaux will be discussed more fully on page 158 of this bulletin.) Basic copper sulphate and high-calcium Bordeaux were practically equal regarding the yields obtained in these tests. The field observations indicated that basic copper sulphate was less effective for the control of flea beetles than were the two types of Bordeaux. Late blight was practically absent from these plots so that the

relative fungicidal value of the different spray materials was not obtained.

Other Comparisons of Different Spray Fungicides. Bordeaux mixture is the spray fungicide most commonly used for potatoes in Aroostook County, Maine. Growers, however, are greatly interested in new materials that might be more effective and easier to employ than Bordeaux. There is need for potato spray materials that do not leave a visible residue on the foliage and yet possess good fungicidal and insecticidal properties. In 1935, several of the newer commercially prepared materials were employed on the Aroostook Farm test plots in the hope of discovering fungicides better suited to the potato industry. The comparative yields secured from these tests are recorded in Table 13.

TABLE 13

Yield Comparison of Different Fungicides Used for Spraying Potatoes in 1935

Fungicides[1]	Barrels per acre	Gain or loss compared with Bordeaux
Coposil, 3 pounds per 100 gallons water	132	8 gain
Bordeaux control (10-10-100)	124	--
Unsprayed control	110	14 loss
Chipman Copper Hydro "40," 8 pounds per 100 gallons water	141	17 gain
Bordeaux control (10-10-100)	124	--
Unsprayed control	110	14 loss
Fungex, 1½ pounds per 100 gallons water	131	14 loss
Bordeaux control (10-10-100)	145	--
Unsprayed control	132	13 loss
Palustrex sulfonate B., 1 gallon to 100 gallons water	119	16 loss
Bordeaux control (10-10-100)	135	--
Unsprayed control	116	19 loss

[1] Coposil, said to contain 22 per cent metallic copper and 67 per cent metallic zinc, supplied by California Spray-Chemical Company, Elizabeth, N. J.
Chipman Copper Hydro "40," said to contain 40 per cent copper hydroxide or 26 per cent metallic copper. Supplied by Chipman Chemical Company, Bound Brook, N. J.
Fungex or Cuprous Oxide, supplied by Metals Refining Company, Hammond, Ind.
Palustrex Sulfonate B., containing copper resinate in pine oil, supplied by E. W. Colledge, G.S.A. Inc., Jacksonville, Fla.

In these tests the plots sprayed with Coposil (having for its active agent ammonium copper silicate) and Chipman Copper Hydro "40" (copper hydroxide) yielded significantly more than the unsprayed controls and the plots sprayed with Bordeaux mix-

ture. Bordeaux, however, was superior to the fungicide known as Fungex (Cuprous Oxide) and Palustrex Sulfonate B. In fact, these two were about the same as no treatment at all.

Potato late blight and other diseases were practically absent from the plots included in these comparisons so that the recorded differences in yield cannot justly be attributed to differences in the control of disease.

Flea beetles were abundant in 1935 and the Fungex and Palustrex Sulfonate B sprays did not serve to repel these insects as did Bordeaux mixture. The injury caused by flea beetles no doubt played a part in the lack of gain, over the unsprayed controls, which resulted with these two spray materials.

Bordeaux mixture, especially when it contained the full amount of lime required by the commonly used formula, appeared to have a depressing and retarding effect on the growth and development of the potato plant during the first part of the growing season. This is less true with some of the other copper containing spray materials. It is possible that the increased yields secured from plots sprayed with Coposil and Chipman Copper Hydro "40" may be attributed to the apparent lack of this depressing effect upon the plants when these materials are used.

Effect of Spraying Potatoes During Hot and Bright Sunny Weather. Growers very often inquire regarding the effect of spraying potatoes during hot weather while the sun is bright and intense. These inquiries were so commonly encountered that a special series of spray applications were made in order to gain information relative to this question. The applications were made on August 20 at a time when the temperature was unusually high for Aroostook County (90-95° F. in the shade). The sun was bright and intense and the conditions quite dry. The following fields were sprayed under the conditions as described.

Field No.	Variety	Condition of Plants
1	Irish Cobbler	Fairly mature, previously sprayed
2	Ditto	Ditto
3	Chippewa	Green and vigorous, previously sprayed
4	Green Mountain	Early planting, previously sprayed
5	Green Mountain	Late planting, previously sprayed
6	Green Mountain	Late planting, not previously sprayed

It is known that the application of Bordeaux mixture may increase the rate of transpiration and in some cases cause leaf injury, and that temporary wilting may occur in young shoots sprayed in sunny weather. In these tests, however, no wilting or foliage injury was apparent.

In each of the tests reported here, non-sprayed controls were included for direct comparison. No differences were apparent between the adjacent sprayed and non-sprayed plots. The information secured thus far indicates that no serious results may be expected under Aroostook County conditions from spraying while the sunlight is bright and the temperature high.

Comparison of Different Spray Schedules. It has generally been recommended that the spraying of potatoes be commenced early in the season and continued until late in the season. The recommendations commonly offered have been to commence to spray when the plants are from 6 to 10 inches high. Work on Aroostook Farm has, however, indicated that the earlier spray applications made when the plants are small may be non-essential in Aroostook County especially in fields where modern spray equipment is used, and that the late summer spray applications are of considerable value, especially during years when rust or late blight is severe.

Tests were conducted in 1934 on Irish Cobblers that had reached their maximum foliage growth and had begun to ripen off. The sprayed plants in this test remained green longer than those not sprayed. This is contrary to the belief of some growers who maintain that potatoes should not be sprayed after they have completed their blooming period.

In 1935, four different schedules were compared in a series of replicated plots on Aroostook Farm. The data pertaining to this test are summarized in Table 14.

Late blight was absent from these tests so that the relative value of the different treatments regarding disease control was not obtained. In the data recorded here, no significant differences were obtained from the different spray schedules. It would seem, however, that the omission of the last three spray applications was beneficial this year. The foliage of the plants was well covered by August 13, little additional growth of the leaves occurred after that date, and no heavy rains occurred. These are factors which ap-

parently made the late spray unnecessary. Other data have indicated that an excessive coating of potato foliage with Bordeaux mixture may reduce the yield rates in the absence of late blight.

TABLE 14

Yields Obtained from Different Spray Schedules in 1935

Treatment	No. of spray applications	Yield per acre		Time of application
		Bushels	Barrels	
Commenced early in season and continued late in season	8	401	146	July 11 to Sept. 10
Delayed first application and continued late in season	6	404	147	July 26 to Sept. 10
Commenced early in season and omitted late applications	5	412	150	July 11 to Aug. 13
Delayed first application and omitted late applications	3	408	149	July 26 to Aug. 13
Non-sprayed controls	0	292	106	None applied

Yield Comparisons with Dolomitic Hydrated Lime vs. High-Calcium Hydrated Lime in the Preparation of Bordeaux Mixture. Spraying experiments conducted in 1933 and 1934 indicated that Bordeaux mixture made with a high-magnesium lime (dolomitic hydrated lime) was superior to a high-calcium Bordeaux for the spraying of potatoes in Aroostook County, Maine. Additional experiments were conducted in 1935 in order to gain additional data regarding the relative merits of these two types of lime for the preparation of Bordeaux mixture.

The tests of 1935 were conducted on two separate fields. The soil of one of these fields was rather poor and depleted of organic matter by continuous cropping with potatoes. The soil of the other field was fairly good and previously had been fertilized by plowing under a cover crop of clover. The two fields each received six applications of spray made according to the commonly used 10-10-100 formula.

The data relative to these tests are summarized in Table 15.

It is to be seen that the Bordeaux made with dolomitic lime was superior in regard to the yields obtained in both of these experi-

ments. The results, however, are not highly significant. In the field, it was noted that the plots sprayed with dolomitic Bordeaux matured less rapidly and appeared to be somewhat more vigorous. This test was also an excellent comparison between yields obtained from a continuous cropping practice in contrast with the practice of plowing under a luxuriant crop of clover at regular intervals. In general, it has been found that dolomitic Bordeaux mixture is superior to a calcium Bordeaux on rather acid soils that have been heavily cropped and where organic matter is relatively lacking.

TABLE 15

Comparison of Yields with Dolomitic vs. Calcium Bordeaux Mixture on Poor and Good Soils

Type of land[1]	Material	Yield rate per acre		Loss in comparison with Bordeaux made with dolomitic hydrated lime		Odds
		Bushels	Barrels	Bushels	Barrels	
Poor	Bordeaux made with dolomitic hydrated lime	283	103	--	--	
	Bordeaux made with calcium hydrated lime	269	98	14	5	4.64 to 1
	Unsprayed controls	170	62	113	41	Very high
Good	Bordeaux made with dolomitic hydrated lime	406	148	--	--	
	Bordeaux made with calcium hydrated lime	387	141	19	7	22.26 to 1
	Unsprayed controls	362	132	44	16	Very high

[1] The poor land had been cropped with potatoes for the three preceding years besides being low in organic matter.

Yield of Potatoes Dug at Different Dates—the Effect of a Long Growing Season on the Yields Obtained. A study has been made, during recent years, of the relative seasonal growth of potatoes receiving different spray and fungicidal treatments for the control of blight and insects. In these studies the potato plots receiving each treatment were harvested in sections at successive dates during the growing season and the yields were compared. The treatments that were compared during each season were in

close proximity to each other, the soil was quite uniform, and the number of replications was sufficient, so that the results obtained can be considered as quite accurate.

In 1935, plots sprayed with Bordeaux (10-10-100) were compared with non-treated controls and with plots that were dusted with copper lime dust (9 per cent). The plots received seven applications during the season. Yields were obtained on seven different dates. Each treatment was replicated in eight 50-foot plots that were harvested by hand digging. The results of these studies for 1935 are given in Table 16.

TABLE 16

Yield Rates at Different Dates for Potatoes Having Received Different Fungicidal Treatments

Date harvested	Barrels per acre for different treatments[1]		
	Bordeaux mixture	Copper lime dust	Unsprayed controls
August 12	60	61	62
August 23	57	65	71
September 2	85	82	90
September 9	91	97	96
September 21	128	120	116
September 28	142	133	130
October 6	157	140	139

[1] The yields reported here are the means from eight 50-foot replicated plots for each treatment. The plots were harvested by hand and the weighings made on a spring balance in the field.

The results of these tests for 1935 show that spraying may be profitable even in years when disease is absent. It is of interest, however, that the non-sprayed controls yielded more than the plots sprayed with Bordeaux until after September 9. This is in conformity with results obtained in previous tests of this nature that have been conducted on Aroostook Farm. If a killing frost had occurred earlier in the season as it does in normal years, it is doubtful whether spraying would have added much, if any, to the yields.

The data that have been obtained indicate that the extent to which the spraying operation gives profitable returns in years of little disease depends to a large extent on the length of the growing season and the date at which the plants are killed by frost. Yield

data gathered over a period of recent years indicate that the Aroostook Green Mountain crop was increased during this period in sprayed fields to the extent of from approximately 40 barrels to nearly 70 barrels after September 10, and that this period is very critical in determining the size of the crop that is obtained.

Spray Service. The spray service was continued in 1935 and has rendered the potato growers of Aroostook County a valuable service. Potato late blight was found to be quite prevalent on July 1 in certain localities of the County. At this early date many growers were still cultivating their crop and very few had made the necessary preparations for spraying. Through the organization of the spray service the growers were given spray warnings regarding the prevalence of blight at this very early date and the consequent danger of a possible epidemic. This information was followed by radio announcements and newspaper articles. As a result of the spread of this information, most of the farmers in the areas where blight was present had sprayed their fields within a few days. It is thought that this service prevented much loss from late blight.

The spray service is under the supervision of the local Farm Bureau and is aided by the Experiment Station workers located at Aroostook Farm near Presque Isle. The service consists of informing the farmers as to when it is planned to spray on Aroostook Farm. The growers also receive timely spray warnings and other information supplied through the radio and the local papers. As a result of this information, farmers have made a more thorough study regarding the problem of spraying on their individual farms and this has resulted in a decrease in the losses from late blight and other diseases.

The use of the spray service is optional with the grower and its popularity can be seen by its rapid early growth and the maintenance of a high number of coöperators enrolled. The following data show the growth and magnitude of the spray service for the past five years.

Year	Number of coöperators enrolled
1931	81
1932	347
1933	2,410
1934	3,006
1935	2,842

VIRUS DISEASES OF POTATOES. (In coöperation with members of the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.)

Nature of Virus Diseases. E. S Schultz, W. P. Raleigh, and Reiner Bonde. Studies have shown that the virus diseases of the potato as found in nature are rather complex and consist of several components. A study of the nature of these diseases and their components is fundamental to investigations on these maladies. Information regarding the various viruses which constitute the different diseases is necessary in order to solve the problems relating to the dissemination of the many virus diseases and resistance of the potato to them.

Mild mosaic was found to consist of two components. One of these is the so-called latent virus found in practically all commercially grown potatoes. It apparently is not transmitted by the aphid species found in Aroostook County, Maine. The other component is readily transmitted by aphids and it must be in combination with the latent virus in order to produce the symptom complex known as mild mosaic.

By the use of aphids it has been possible similarly to separate the distinguishing components of crinkle, leafrolling, rugose, and aucuba mosaic, as well as of leaf roll and spindle tuber, from latent mosaic.

Leaf roll symptoms were not modified by the kind of seedling, but mild mosaic symptoms varied much with the seedling variety.

Green Mountain Seed Plots. Donald Folsom. Tuber-line seed that had been produced under an aster-cloth cage at Highmoor Farm in 1933 was planted by the tuber unit method in two open fields at Highmoor Farm in 1934 under conditions of apparently good isolation. These two fields were free of virus diseases. The crop in 1934 was mostly sold to growers, who planted about 45 acres from it. Their seed plots were located in seven counties ranging the length of the state (See Fig. 27.) Most plots were rogued carefully and most of the crop from them should be suitable as foundation stock. Records available from 42 acres give about three mosaic hills per acre, about eight leaf roll, and about three yellow-top, the total being about one-tenth of one per cent. Each disease was absent from about half the plots, and all diseases were absent from five plots.

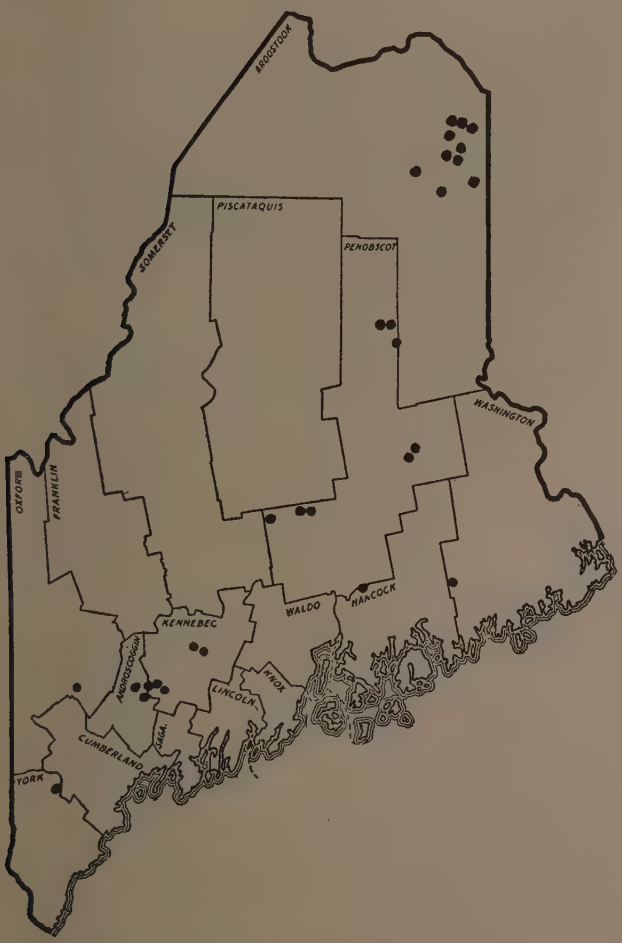

FIG. 27. Location of Green Mountain foundation stock seed plots planted in 1935 from Highmoor Farm stock originated under a large aster cage in 1933.

Although the practical value of this seed stock was not greatly reduced by virus diseases, their entrance in 1934 under the prevailing conditions shows that the isolation was not great enough. No potatoes were nearer than two miles except a field which was good

enough to be certified, nearly a mile distant, and garden patches of similar stock. Enough virus disease entered to infect about ten hills per acre.

Virus diseases did not enter seed stock while under a cage in 1934. This seed stock was planted May 2, 1934, was covered with the cage on May 25, and was not attacked by plant lice until after August 21 when part of the top cloth was ripped by wind. Some tops in the cage remained green until September 18 and the crop was dug October 9. This would have allowed virus diseases to reach the tubers had they infected the tops through the plant lice observed.

The yellow, treated kind of aster cloth withstood the elements better than the white, untreated kind. One commercial seed grower covered a half acre plot with cloth this summer. The crop from the Highmoor Farm fields of 1935, planted from the aster-cage crop of 1934, has been sold to seed growers.

Insects in Relation to the Transmission of Virus Diseases of Potatoes. G. W. Simpson. For the practical control of virus diseases of the potato, isolated tuber unit seed plots continue to prove effective. During the past season, experimental seed plots were again rogued by an experienced worker under the supervision of the Department of Plant Pathology. The plots were inspected at approximately weekly intervals from the first of July to the middle of August. As soon as detected, all diseased plants were pulled from the soil, placed in bags, transported to a distance of at least one mile from the seed plot, and destroyed.

The areas studied during 1935 fall into two groups. The one highly successful location is an isolated farm where all the potatoes grown are planted by tuber units and rogued throughout the season. The three locations falling into the second group are farms where other seed stocks, more or less diseased, are planted in the immediate vicinity of the experimental plots. Although these three locations have not been successful from a practical standpoint, in each case the incidence of disease has been reduced to a point not attained with unrogued seed on these same farms.

Still another location has been the most successful in these experiments, but it was not studied in 1935 because of its having passed into the control of a coöperative organization, employing its own plant pathologist who is maintaining this stock for the bene-

fit of the organization's members. From the seed raised on this farm in a seed plot which in 1934 contained no detected mosaic plants, some 28 acres were planted in 1935. This whole area having been planted in 1935 by tuber units and rogued, it was possible to obtain a highly accurate disease reading on the progeny of the plants grown in the 1934 seed plot. In one area, about two acres in extent, approximately 25 hills of mosaic were removed by the grower in 1935. No mosaic plants were detected on the remaining 26 acres. Hence, it seems logical to assume that the seed plot in 1934 probably contained no mosaic plants originally and that during that season one hill, or, at the most, two hills became diseased, since 25 hills in 1935 could easily have been planted from the progeny of a single hill grown in 1934. Because some diseased hills were removed from commercial fields on this farm in 1934, a source of infection is known to have been present.

One of the areas studied in 1935 was among the areas originally chosen for experimental work and it has continued to be successful from the first. The farm is isolated from other farms by miles of forest growth except to the east where there is somewhat less than a mile of woods separating this farm from its nearest neighbor. Seed stock originally of high quality from the standpoint of virus diseases has been maintained in a very satisfactory condition during subsequent seasons. During 1934 no mosaic was detected in the seed plot grown on this farm. Seed selected from this plot at the end of the 1934 season was planted in a three-acre seed plot in 1935. From these three acres planted with seed from about 10,000 tubers, seven tubers produced plants showing the symptoms of mild mosaic. These diseased tubers having come from lots harvested on two different dates, it seems evident that at least two plants must have become infected during the 1934 season. Since diseased plants were present in the commercial fields, the source of this infection may be inferred as having been on the farm itself.

In the case of one seed plot located in an area long given over to the growing of table stock and, as one might expect, an area in which much diseased seed stock is planted, definite improvement in the experimental seed stock was noted during the past season. First planted in 1933 in a plot averaging about eight-tenths of one per cent of mild mosaic, this seed stock showed evidence in 1934 of having become contaminated in 1933 from outside sources. That

is, during the 1934 season, approximately seven per cent of the plants in the plot showed symptoms of mild, crinkle, or rugose mosaic and were removed. Plants showing the symptoms of crinkle and rugose mosaic were found in 1933 in unrogued table stock fields about 250 feet distant from the 1933 seed plot. Such plants, together with those showing symptoms of mild mosaic, were present in the commercial fields to the extent of 40 per cent or more of all plants.

The progeny of the 1933 plot, being nearly sufficient for the needs of the grower, were planted on his farm in 1934. In this way the incidence of disease in the unrogued commercial fields on this farm was reduced from about 40 per cent in 1933 to about six or seven per cent in 1934. Again in 1934 the seed plot, from which about seven per cent of the plants were removed during that year, was isolated by a distance of 250 feet from the commercial fields. Before the planting of the 1935 crop, the grower placed as much of his 1934 crop as possible with neighboring growers, thus reducing the incidence of disease in the seed stocks planted in his immediate vicinity. For his own commercial fields he used seed from his 1934 seed plot. During 1935, slightly more than two per cent of the plants grown from seed harvested from the 1934 plot proved to be infected with mild mosaic. A count made in the commercial fields on this farm showed a slightly higher percentage (2.5 per cent) of the plants showing symptoms of mild mosaic. It is evident from the record for 1935 that as a result of the roguing done during 1934, crinkle and rugose mosaic were successfully eliminated from this seed stock; likewise it is evident that crinkle and rugose mosaic did not enter this seed stock from neighboring commercial fields. The mild mosaic found may have entered the plot, or may have spread within the plot from the diseased units removed during 1934.

It seems evident that, in the particular locality in question, the incidence of disease in neighboring commercial fields has influenced the results obtained in the seed plot. As the seed stock planted in the commercial fields has been improved, with respect to virus disease infection, the seed stock in the rogued seed plot has likewise shown a successively lower incidence of disease. This area has presented an excellent opportunity for a study of the responsibility of the community as a whole, if seed stocks in a given area are to be

improved. The individual grower, in this case at least, was handicapped by the practices of his neighbors. If subsequent events substantiate the present trend, the ever widening use of better seed stocks which are being developed gradually on this farm and which are being utilized by neighboring farmers will prove of benefit to the whole community.

A record of the aphid population present in the four experimental plots studied in 1935 was made from time to time throughout the season. Similar records were made during the latter half of the season for five additional plots. Each of these five plots was located in the Caribou area and each was planted with mosaic-free seed from Highmoor Farm seed, which is being tested by the Department of Plant Pathology. The information obtained from these five plots will be of value in determining some of the conditions under which field to field transmission of mosaic takes place and will also help to answer the question as to what constitutes adequate isolation of seed plots.

Tuber indexing of two stocks, one having a low disease content (mosaic 0.1 per cent), the other high (mosaic 7 per cent), was done during the winter. In both cases the results indicated rather closely the relative condition of the stock as revealed later during July in the field.

Experiments conducted during the summer of 1934 in field cages with small numbers of the peach and buckthorn aphids (*Myzus persicae* and *Aphis abbreviata* respectively) indicated that under the conditions of the experiments (with aphids being transferred from diseased to healthy plants near the end of July) about 800 aphids per plant were required to effect transmission of the mosaic virus.

Greenhouse experiments in which the aphids, *Myzus persicae* and *M. circumflexus,* were used as vectors resulted in the transmission of mosaic only when numbers in excess of 100 aphids per plant were used. However, not every case in which 100 aphids were transferred resulted in transmission of mild mosaic. Leaf roll was transmitted by both species much more readily in this experiment than was mild mosaic. Several instances of transmission of leaf roll by a single individual of each species were recorded. In all cases the aphids were transferred to healthy, young potato plants which had put out six or eight leaves. Readings on the progeny of the

experimental plants indicating a diseased or healthy condition (i.e. transmission or nontransmission) were furnished by the Department of Plant Pathology.

Comparison of Two Aphid Species Regarding Transmission of Mild Mosaic, Leaf Roll, and Spindle Tuber. E. S. Schultz, W. P. Raleigh, and Reiner Bonde. Studies are being conducted in order to learn whether the different aphid species found on the potato in Aroostook County, Maine, differ in their ability to disseminate the virus diseases. In the studies of 1934, the peach aphid, *Myzus persicae,* and the buckthorn aphid, *Aphis abbreviata,* appeared to be similar in their ability to transmit the distinguishing components of mild mosaic and leaf roll while neither transmitted the distinguishing component of spindle tuber. The buckthorn aphid transmitted the distinguishing component of mild mosaic in experiments as readily to seedling 41956 as to Green Mountains, although in the field this seedling seems more resistant.

CONTROL OF FLEA BEETLES ON POTATOES. G. W. Simpson. The absence of late blight in the experimental plot during the growing season of 1935 presented an excellent opportunity to study the effect of various poisons, added to Bordeaux mixture, in an attempt to prevent injury from the feeding of flea beetles on the foliage of the potato plants. Six spray applications—somewhat less than would be applied in a normal season—were made with a power take-off sprayer having three nozzles per row. The first application did not include poison. To the following five sprays, poison was added. A comparison was made between Bordeaux mixture alone, Bordeaux with calcium arsenate added, and Bordeaux with barium fluosilicate added. The calcium arsenate was added to the Bordeaux at the rate of three pounds per 100 gallons of spray; the barium fluosilicate was added at rates of three pounds and six pounds respectively per 100 gallons.

As in 1934 little gain in yield was obtained by the use of calcium arsenate. The barium fluosilicate tended to decrease the yield slightly, the heavier application apparently decreasing the yield somewhat more than the lighter application. The differences in yield, however, were not great and possibly are of no significance.

WIREWORM CONTROL. John H. Hawkins. The study on wireworms and their control was begun in 1926 and the results of this study are now in manuscript form and will soon be available as

Bulletin 381 of the Maine Agricultural Experiment Station. Especial reference is made to wireworms in relation to the practical problems of potato growers. The life cycles of these pests are explained in detail from egg to adult. The control measures which have been found to be satisfactory on potato farms during nine years of study are fully outlined in this bulletin.

LOSSES DUE TO SEED PIECE DECAY AND BLACKLEG. Reiner Bonde. Large losses occur to the potato crop each year because of poor and uneven stands following the failure of the sets to germinate and produce plants. The data in Table 17, based on a survey conducted in Aroostook County, demonstrate to some extent the importance of this trouble.

TABLE 17

Percentage of Hills Missing in Potato Fields in Aroostook County, Maine

Per cent stand	Percentage of total fields in different classes	
	Irish Cobbler	Green Mountain
96-100	7.5	3.3
90-95	50.0	50.0
80-89	35.0	40.0
70-79	5.0	3.3
Below 70	1.0	3.3

It is to be seen that nearly 50 per cent of the fields suffered considerable losses because of more than 10 per cent missing hills. The average stand was 88 per cent for Cobblers and 87 per cent for Green Mountains. Poor stands result from many factors of which several will be mentioned here. The Rhizoctonia disease in some seasons plays an important role in reducing the stands, especially when the spring season is wet and cool. This trouble can be avoided to a large extent by proper seed treatment methods and by better selection of the seed stock to be used for planting the tuber unit seed plot.

Observations within the past year have shown that very often cut seed potatoes are injured by exposure to drying winds and sun-

light. When this occurs, they lose the power to heal over properly and they soon decay when planted in moist soil. Potato growers are urged to keep their seed stock covered and protected until it has corked over. Seed, if freshly cut, may be severely injured and rendered unfit for planting by allowing it to stand in barrels in the open field, during warm, dry weather.

Seed piece decay often results from contamination by bacteria and fungi. This often results as a secondary condition following the practice of planting seed pieces that have been injured by excessive drying. Sometimes these pathogenic organisms are spread by the cutting knife. The seed cutter may cut a rotted tuber and then proceed to cut succeeding tubers with the same knife before it has been disinfected. In this manner the rotting organisms are spread to healthy seed pieces which are thus inoculated and will decay under conditions favorable to decay organisms. Partially diseased tubers and seed pieces also may be dropped into a lot of freshly cut seed. In the process of stirring and dumping the seed stock these decayed seed pieces spread the infection to healthy seed pieces. Growers should warn their seed cutters to remove all decayed tubers and to disinfect the cutting knives if they become contaminated.

The survey of 1935 revealed that the blackleg organism is responsible for much of the seed piece decay that occurs in Aroostook County. According to the data secured more than 80 per cent of the Irish Cobbler fields and 65 per cent of the Green Mountain fields had the blackleg disease. The amount of the disease found ranged from a trace to 12 per cent. The average amount of blackleg for all the fields examined was 1.86 per cent for the Irish Cobblers and 1.17 per cent for the Green Mountains. This is significant when the importance that blackleg has on the seed potato trade and certification rules is realized. According to seed certification rules the presence of more than 1 per cent of blackleg disqualifies a seed stock. Furthermore, those fields which contained blackleg also had a high percentage of missing or small hills, which resulted in lowered yields. Besides this, roguing of a field to eliminate blackleg is expensive and rather ineffective.

It is felt that the prevalence of the blackleg disease can be greatly reduced by better seed selection, by thorough roguing of the sources of seed, and by exercising greater care in handling and storing the seed stock after it has been cut.

Seed Treatment for Rhizoctonia Control. (In coöperation with members of the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.) W. P. Raleigh and Reiner Bonde. Various standard seed treatment methods and new materials have been compared on Aroostook Farm for the control of the Rhizoctonia disease. The results of these experiments conducted during the years 1929 to 1933 justify the following tentative conclusions which are of interest to potato growers. Treatment of Irish Cobbler tubers infected with Rhizoctonia or black scurf, usually increased the stand, increased the average vigor of the plants, reduced the percentage of infected tubers, and increased the yield. Treatment of Irish Cobblers free from Rhizoctonia infection, and of field-run Green Mountains, however, did not increase the yields in these tests. In previously conducted experiments the practice of treating relatively diseased tubers did increase yields materially, especially during seasons when seed piece decay was prevalent.

Acidulated corrosive sublimate (corrosive sublimate 1-500 with 1 per cent HCl) used as a three-minute dip treatment method was satisfactory regarding the control of Rhizoctonia but seemed to be somewhat more dangerous from the standpoint of injury to the tubers than the standard corrosive sublimate treatment when used by farmers. (The standard treatment consists of soaking the seed tubers for 90 minutes in a solution consisting of four ounces of corrosive sublimate dissolved in 30 gallons of water.) Growers who desire to use the acidulated corrosive sublimate dip treatment should take care to dry the treated tubers carefully before they are stored. The acidulated mercury dip method has not given tuber injury when used in experiments on Aroostook Farm provided the tubers were thoroughly dry before being stored.

A solution of corrosive sublimate 1-1,200 and potassium iodide 1-400 used as a dip treatment method gave promising results. The cost of potassium iodide, however, renders this method impractical under the prevailing conditions. The organic mercury dips used were slightly inferior to the standard corrosive sublimate treatment in regard to Rhizoctonia control. They are, however, very convenient to use and are preferred by some growers because of this advantage.

It is of special interest that seed tubers free from Rhizoctonia failed to become infected when planted in the field. This suggests that most of the disease that does occur results from planting seed stock bearing the Rhizoctonia fungus. The results indicate that much progress can be made in reducing the amount of Rhizoctonia on our seed stock by more careful tuber selection, especially for planting in the tuber unit seed plot.

YIELD COMPARISON BETWEEN GREEN MOUNTAIN AND RUST PROOF. Reiner Bonde. The Rust Proof variety is being grown by some farmers because it is resistant to tuber rots and can withstand rust epidemics without being sprayed. In years when late blight is prevalent, this variety has yielded quite favorably in comparison with other varieties. In 1935, the Rust Proof variety was grown in comparison with the Green Mountain variety in a series of replicated tests. The plots were not sprayed and disease was practically absent. The yields secured from these comparisons are in Table 18.

TABLE 18

Comparison of Green Mountain and Rust Proof Varieties Unsprayed

Variety	Yield per acre		Per cent small and unmarketable tubers[1]
	Bushels	Barrels	
Green Mountain	327	119	10
Rust Proof	276	101	25
Difference in yield	51	18	

[1] Included in the yield per acre.

In the yield comparisons reported here, the Green Mountain variety was highly superior to the Rust Proof. The season was quite dry, a condition which resulted in many tubers being small and unmarketable. This greatly affected the yields secured.

The Rust Proof variety has been most valuable as a parent plant for use in breeding studies for resistance to late blight and other diseases. Work in progress by members of the United States Department of Agriculture has given new seedlings that also possess resistance toward late blight and tuber decays.

Distribution of New Seedling Varieties of Potatoes. Reiner Bonde. Three new potato varieties have been developed on Aroostook Farm through the coöperative work being done with the United States Department of Agriculture. The named seedling varieties that have been originated through these efforts are the Katahdin, the Golden, and the Chippewa. The Experiment Station has increased the original stock of these new varieties and has rendered them nearly free from disease prior to being distributed among the growers.

The Katahdin is already a commercially established variety and is being grown by some growers for the seed trade. The Chippewa is a more recent production and promises to be very popular. The Experiment Station and the United States Department of Agriculture have received numerous requests for foundation seed stock of this new variety.

In 1933, ten growers received small quantities of the Chippewa and in 1934 approximately 100 barrels of this variety were distributed in Aroostook County. It is expected that in 1936 a considerable amount of disease-free seed stock will be produced on Aroostook Farm for growers who wish to receive a start in testing out the Chippewa on their home farms.

Killing of Potato Vines with Sulfuric Acid To Hasten Maturity. Reiner Bonde. The year 1935 was characterized by an exceptionally long growing season in Aroostook County. A killing frost did not occur on Aroostook Farm until October 7. Many potato fields that had been well fertilized and sprayed continued to grow until killed by freezing. This prolonged growth of the vines caused considerable anxiety among growers. Those potato growers who dug their crop while it was immature experienced large losses due to bruising and skinning of the green tubers. Still greater losses occurred because of tuber cracking, which will be discussed in a later section of this bulletin.

Due to these losses and the need of digging the crop before cold weather and snow occurred, there was a great deal of interest in the methods that could be used for killing the green potato vines and hastening the maturity of the potato crop.

Spraying with a solution of commercial sulfuric acid has been successfully employed in Europe as a method for killing potato tops and hastening the maturity of the tubers. In view of

these successful reports this product was tested for killing potato tops under Aroostook conditions.

In these tests commercial sulfuric acid (66° Bé.) was diluted in water to different strengths and sprayed with a hand machine onto Green Mountain potato vines. The spraying was done on September 6 and 12 and October 2. The results of these tests are summarized in Table 19.

TABLE 19

Summary of Results Obtained in Killing Immature Green Mountain Potato Vines with Sulfuric Acid

No. of test	Date sprayed	Concentration of acid by weight	Effectiveness of application
		Per cent	
1	September 6	3.5	Killed most of leaves but not the stalks.
2	September 6	5.0	Killed leaves but not the stalks. More effective than 3.5 per cent.
3[1]	September 12	7.0	Killed all remaining leaves and tender shoots. Plants died within one week.
4	October 2	3.5	As No. 1.
5	October 2	6.0	Killed all leaves and tender shoots. Fairly effective kill.
6	October 2	12.0	Killed all leaves and most of stalks.

[1] Nos. 1 and 2 resprayed.

In these tests 3.5 per cent of sulfuric acid by weight was the weakest concentration employed. At this strength the tender leaves were mostly killed but the stalks remained green and were uninjured. A 5 per cent acid solution was much more effective and killed the leaves but also failed to injure the stalks.

The plants previously referred to (which had been sprayed with a 3.5 per cent and a 5 per cent acid solution) were sprayed again one week later with a 7 per cent solution. This second spray application killed the remaining leaves and injured the stalks so that they died within a week.

On October 2, potato vines were sprayed with three different strengths of acid solution. The results with a 3.5 per cent acid solution were quite similar to those obtained on September 6. When the acid content was increased to 6 per cent a fairly effective kill was secured. At this concentration all of the leaves and tender

shoots were killed to such an extent that foliage would soon be dead. A 12 per cent solution was more effective and gave almost a complete kill of the foliage.

The results obtained have shown that green potato foliage can be effectively killed if it is sprayed with a solution of sulfuric acid. Approximately a 6 to 7 per cent solution by weight gave the most practical degree of kill in these tests. A 12 per cent solution killed the foliage more extensively than a 6 per cent solution but the difference was not enough to warrant the use of the higher concentration.

The killing of potato foliage by the use of sulfuric acid may have some practical uses in Maine. Growers of certified seed potatoes may find it desirable to kill the plants in their seed plots early in the season in order to prevent the late spread of leaf roll and other virus diseases into the tubers of the seed stocks. During some seasons, when the crop is late in maturing, the vines may be killed with acid and the maturity of the crop thus hastened. Sulfuric acid also is an excellent weed killer and may be found to be very useful in destroying wild mustard and kale which are serious pests in Aroostook County. Sulfuric acid is cheap to use and suitable attachments to the regular potato spray equipment are available.

TUBER CRACKING IN GREEN MOUNTAINS. Reiner Bonde. Part of the growing season of 1935 was exceptionally dry for Maine conditions, the result being a marked retardation of plant growth during the beginning and middle of the regular growing season. Rains were, however, abundant during the latter part of the season with the result that the fields of Green Mountain potatoes in Aroostook County took on new life and resumed growth at a rapid rate. Also, killing frosts did not come until a very late date. As a result of the abnormal season the plants continued to grow until killed by freezing on October 7. The immaturity of the crop and greenness of the vines are shown by the fact that on October 6 the average weight of green foliage per plant in our experimental plots was approximately 1.5 pounds, or more than 10 tons per acre.

The late maturity of the potato fields caused considerable anxiety among the potato growers who wanted to begin their harvesting operations before heavy frosts and settled cold weather set in. As a consequence many fields were harvested before the foliage was dead and the tubers had ripened. When these green fields were

dug, severe cracking and bursting of the tubers occurred quite commonly. The cracking resulted in most cases when the turgid tubers received a sudden jar or a thump while being dug and handled. This phenomenon was absent in the Irish Cobbler variety and in those Green Mountain fields which had matured early. The observations in Table 20 relative to this problem are of interest.

TABLE 20

Percentage Tuber Cracking in Green Mountains Harvested at Two Different Dates

Date of digging and number of tubers in lot	Per cent tubers cracked		
	On soil in field	On being dumped into barrels[1]	On being rehandled[1]
September 15			
150	4	12	6
100	4	35	14
100	7	15	4
100	2	15	--
100	5	40	--
200	11	24	12
October 18			
200	2	4	0
250	3	4	0
300	6	3	0

[1] Percentage of those not previously found to be cracked.

The data indicate that only a small proportion of the tubers were cracked in the digging operation. Field records revealed that the greatest proportion of the cracking occurred as the tubers were being dumped by the pickers from the basket into the barrels in the field. The data also show that the tendency to crack decreased greatly from September 15 to October 18.

Some growers maintained that the tubers cracked when merely exposed to the air and that a bruise or jar was not necessary. This point has not been substantiated. An examination of tubers revealed that nearly 90 per cent of the cracking was associated with bruises. Very often slight bruises and jars such as occur in picking and dropping the potatoes into baskets, resulted in the tubers breaking open. The observations of the writer indicate that this phenomenon disappeared as the season progressed and the tubers were allowed to harden and ripen off before being harvested.

Cooking Quality of Potatoes. Marion D. Sweetman. Studies on the hydrophilic quality of potato starches were continued with the testing of the gelatinized volumes of well-washed, vacuum-dried starches from 10 lots of potatoes varying in mealiness when cooked. When these starches were gelatinized in the juice of potatoes of a single variety prepared by filtration to remove starch and fiber, and by heating followed by a second filtering to remove coagulated protein, the volumes of the swollen starch ranged from 22.0 to 33.5 cc. and averaged 25.5 cc. per 0.5 gram as compared with 111.7 cc. per 0.5 gram for distilled water gelatinization. Thus the conditions of the tuber environment are shown to have a highly depressant effect upon the swelling of starches of the potato. However, swelling in the juice of a single variety did not reveal inherent characteristics of the starch that correlated with mealiness in the lot from which it was secured. There was no closer correlation of swelling with mealiness than in distilled water gelatinization.

Further investigation of the relation of the swelling power of the starch, in the tuber environment, to mealiness included the comparison of gelatinized volumes of a starch in the juice of its own lot, of a very mealy lot, and of a decidedly non-mealy lot. There was no regular relation between swelling in self-juice and mealiness, nor did the juice of the most mealy variety have a consistent effect on relative swelling, but the juice of the least mealy variety gave the least swelling in every case. This suggests the desirability for further study of the ionic content of the juices of non-mealy tubers. Present evidence indicates that mealiness is not controlled entirely by total starch content, nor to any great extent if at all by its inherent swelling capacity, or its swelling capacity under conditions of the tuber environment.

Cooking tests of variety and fertilizer plot samples from Aroostook Farm were continued this year. In both 1934 and 1935, tubers from plots receiving the fertilizer applications 4-0-7, 4-8-4, 4-8-7, and 4-8-10, were more mealy when cooked than those receiving 4-8-0 and 4-8-14 mixtures. This seems to indicate that there is a wide range for potash so far as quality is concerned, but that its absence in fertilizers or its presence in very large proportions causes a degree of inferiority in mealiness. In this series, the highest potash treatment gave less than 10 per cent higher yield of potatoes per acre than the 4-8-10 mixture, which gave the next highest in yield.

Thus high yields per acre are not incompatible with mealiness of the cooked potatoes. This year potash in the sulfate combination was not noticeably superior to potash in the chloride combination in its effect on mealiness of potatoes.

Tests for four years on mealiness of tubers of the following varieties: Green Mountain, Irish Cobbler, and Bliss Triumph, have shown them to rank in descending order for mealiness every year. In two successive seasons, the Green Mountain, Irish Cobbler and Chippewa, and Bliss Triumph varieties have ranked in mealiness in the order named. Tubers of the Katahdin variety grown at Aroostook Farm were in the Bliss Triumph class in mealiness this year. Of course, these fertilizers and variety ratings might be different for potatoes grown under different environments.

DAIRYING

AN ECONOMIC STUDY OF THE DAIRY INDUSTRY IN MAINE. George F. Dow. Considerable progress has been made during the past year in the dairy farm organization and management studies which have previously been reported in Bulletin 377.[1] The information used in these studies includes 290 dairy farm records secured in 1933 in the wholesale milk and cream areas of Unity, Brooks, Belfast, and Union; 116 records secured in 1934 in the wholesale milk area of Farmington; and 148 records obtained during the same year in the Portland area. These last records were from dairymen who sold milk wholesale to the larger milk dealers in the Portland market.

Since July 1, 1935, most of the dairy research work has been confined to a new phase of the dairy study dealing with the cost of producing and marketing milk in local retail markets. This new study has been pushed as rapidly as possible due to the urgent demand for production and distribution costs as a result of the establishment of the State Milk Control Board which began to fix producer and consumer prices in April, 1935.

Cost of Producing and Distributing Milk in Local Retail Markets. Costs of distributing milk and cream were secured from 129

[1] Summary Report of Progress, 1934. Me. Agr. Exp. Sta. Bul. 377. 1934.

dairy dealers for the year ending April 30, 1935, which was the year prior to the establishment of the State Milk Control Board. Of these dealers, 66 sold milk and cream in the vicinity of Portland, 35 in the vicinity of Waterville, and 28 in the vicinity of Bangor.

In addition to distributing milk and cream, 108 of the 129 dealers kept dairy herds of their own, producing all or part of their milk supply. These producer-dealers, including 55 in the Portland area, 33 in the Waterville area, and 20 in the Bangor area, also furnished complete information on their cost of producing milk.

These records of production and distribution costs will be used to make many useful comparisons. It will be possible, for example, to compare the distribution costs of the large dealers who buy all of their milk supply with the costs of the producer-dealers who keep dairy herds of their own. Comparisons can also be made of the cost of producing milk in the herds of these producer-dealers who live in or near the market with costs in herds more distant where milk is shipped to the larger dealers.

Many of the computations have already been completed and it is possible, at this time, to report on certain phases of the study.

COST OF PRODUCING MILK IN HERDS OF PRODUCER-DEALERS IN THE PORTLAND AREA. The dairy herds of the producer-dealers in the Portland area contained an average of 17 cows per herd. These cows produced an average of 6,845 pounds of milk per cow. Grain was fed on the basis of an average of one pound of grain to 2.3 pounds of milk.

The average cost of producing milk was 5.5 cents per quart on the basis of milk testing 4.0 per cent butterfat. This cost includes not only cash expenses, such as grain and hired man labor, but also includes a fair value for all items chargeable to the dairy herd, such as home-grown hay, pasturage, family labor, and the use of buildings and equipment. A credit has similarly been made based on a fair value for manure and for the calf when born. Feed and labor costs were by far the two most important items, comprising 80 per cent of the cost of milk production. Feed represented 58 per cent and man labor was 22 per cent of the total cost.

The cost of 5.5 cents per quart of milk represents the net cost of *all* milk produced. This cost is, therefore, not sufficiently high to be used as the sole basis for paying the farmer for his *fluid* milk unless such a farmer has an opportunity to sell *all* of his milk on a

fluid milk basis. Obviously, if part of the farmer's milk must be sold at a low surplus price, which averaged 3.9 cents per quart for 4 per cent milk at Portland for November, 1935, a correspondingly higher price must be received for fluid milk sales. For example, if a farmer sold 20 per cent of his milk as surplus at 3.9 cents per quart, his fluid milk price should have been 5.9 cents to compensate him for production costs. If the surplus amounted to 30 per cent, the fluid milk price should have been 6.2 cents per quart.

TABLE 21

Summary of the Net Cost of Producing Four Per Cent Milk in Dairy Herds Kept by Producer-Dealers in the Portland Area
(Year ending April 30, 1935)

Item	Cost per cow	Per cent of total
Costs:		
Feed	$ 113.77	58.3
Man labor	43.46	22.2
Use of buildings	9.00	4.6
Use of equipment	2.09	1.1
Bedding	3.87	2.0
Bull service	3.18	1.6
Cow depreciation	9.75	5.0
Interest on cows	3.86	2.0
Miscellaneous	6.27	3.2
Total costs	195.25	100.0
Returns:		
Value of manure	17.78	85.1
Value of calf born	2.37	11.4
Miscellaneous	.74	3.5
Total returns	20.89	100.0
Net cost of producing milk	174.36	
Pounds milk per cow[1]	6,845.00	
Net cost per cwt. of milk[1]	2.55	
Cost per quart of milk[1]	.055	

[1] Based on equivalent of milk testing 4.0 per cent butterfat.

COST OF PRODUCING MILK IN HERDS OF PRODUCER-DEALERS IN WATERVILLE AND BANGOR AREAS. Although all the details of production costs have not yet been checked for herds of producer-dealers in the Waterville and Bangor areas, preliminary figures show that their costs per quart of milk are from one-half to one cent a quart less than in the Portland area. The reasons for this reduction in costs are due to such factors as lower real estate values

and a lower cost for hired labor. The price of hay in the Portland area, for example, during the year ending April 30, 1935, was valued at $14.89 per ton as compared with $12.67 at Waterville, and $11.49 at Bangor. The value of cleared pasture land in the Portland area was $30 per acre, in contrast to $19 at Waterville, and $22 at Bangor. Man labor costs were 24 cents per hour in the Portland area, and 20 and 22 cents in the other two areas respectively.

Studies of production costs[2] that have been made by the Maine Agricultural Experiment Station indicate that the costs of producing milk in the Portland area are approximately one-half cent per quart higher than in the wholesale milk areas supplying the Boston market. Production costs for the year ending April 30, 1935, averaged 5.0 cents per quart in areas supplying Boston as compared with 5.5 cents per quart in the Portland area. Production costs for the Boston markets during this period are based on a previous study which gives a formula for computing production costs based on current prices.[3]

The same formula, as indicated above, also makes possible a determination of the recent trends in production costs in the Portland market. Thus production costs from April 1 to July 31, 1935, (the first four months under the State Milk Control Board) were 5.5 cents per quart for 4.0 per cent milk—exactly the same as the average cost during the previous twelve months. Based on prices from August 1 to November 31, 1935, the cost of production dropped to 5.1 cents per quart. This decrease of nearly one-half cent per quart was due to lower prices of hay and grain as a result of increased crop yields in 1935.

COST OF DISTRIBUTING MILK BY THE FOUR LARGEST MILK DEALERS IN THE PORTLAND MARKET AREA. In the analysis of distribution costs, the four largest dealers were included in a separate group because they had much larger volume than any of the other dealers.

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[2] Dow, George F. Costs and Returns in Producing Milk, Raising Heifers, and Keeping Herd Bulls in Maine. Me. Agr. Exp. Sta. Bul. 361, pp. 155-156. 1932.

Dow, George F. Unpublished data of production costs during year ending April 30, 1934, comparing herds in the Farmington area which shipped milk to Boston with those in the Portland area which supplied milk to the larger Portland dealers.

[3] Same as first part of reference 2.

The total volume handled by these four dealers was approximately three times larger than the total volume handled by the 62 other dealers, whose records were included in the Portland area.

The total volume of milk and cream and other dairy products sold by these four dealers is summarized in Table 22. The volume of milk wholesaled was slightly larger than that of milk retailed direct to the consumers. The proportion of wholesale milk was relatively higher in the case of the large dealers than for the smaller dealers. For the latter group, retail sales were nearly twice as large as the volume wholesaled. Of all milk wholesaled by the large dealers approximately 29 per cent was sold in cans, 51 per cent in quart bottles, 8 per cent in pints, 2 per cent in 10-ounce bottles, and 10 per cent in half-pints. Retail sales of milk were 91 per cent in quart bottles and 9 per cent in pints.

TABLE 22

Total Volume of Milk, Cream, and Other Dairy Products Sold by the Four Largest Dealers in the Portland Market Area During the Year Ending April 30, 1935

Container	Quarts milk		Quarts cream	
	Wholesale	Retail	Wholesale	Retail
Cans	961,206	--	343,263	--
Quart bottles	1,683,662	2,844,765	81,262	10,653
Pint bottles	246,022	278,006	40,877	48,682
Ten-ounce bottles	59,347	--	--	--
Half-pint bottles	340,833	--	124,050	57,868
Total	3,291,070	3,122,771	589,452	117,203
Quarts special grades milk	83,823	1,716,751		
Quarts skim milk and buttermilk	566,852	74,389		
Quarts ice cream mix	48,112	--		
Pounds of butter	20,001	10,805		
Pounds of cottage cheese	--	12,836		
Pounds of condensed milk	12,462	--		

Of the total cream sold by the four largest dealers (including heavy, medium, and light cream), 83 per cent was wholesaled and 17 per cent was retailed.

Each of the four large dealers made records available so that it was possible to determine accurately the cost of distribution. Such costs as depreciation charged for buildings and equipment, salaries of officers, and the amount written off as allowance for bad

debts were given definite consideration. In a few cases slight adjustments in these costs were made upon mutual agreement of the dealer and the person conducting this study. In this study, interest has been computed at a uniform rate of 5.0 per cent, charged on the present value of the investment in dairy plant, equipment, and other capital requirements. It was believed that this was a fair expense to charge for the use of capital invested in the distribution of milk. This is also the same rate of interest as that charged in the determination of milk production costs.

The total cost of distribution for these four dealers was $515,812 for the year. This includes, as previously indicated, all cash costs plus a fair charge for depreciation on real estate and equipment, 5 per cent interest on the present value of the investment, and a reasonable allowance for loss of bad debts. Of these costs, about 52 per cent was for wages and salaries, 13 per cent for motor trucks and horses, and 10 per cent for the dairy plant and equipment costs. Dairy supplies and other processing and miscellaneous costs accounted for the remaining 25 per cent.

TABLE 23

Cost of Distributing Milk and Cream by the Four Largest Dealers in the Portland Market Area During the Year Ending April 30, 1935

Item of cost	Total cost	Per cent of total
Wages and salaries	$271,621	52.6
Motor truck costs	53,867	10.4
Horse, harness, and wagon cost	11,714	2.3
Use of milk plant	18,079	3.5
Use of milk equipment	31,170	6.0
Supplies:		
Bottle caps	12,924	2.5
Bottles	10,520	2.0
Washing powder	2,015	.4
Laundry	1,494	.3
Paper and office supplies	7,861	1.5
Electric lights and power	3,389	.7
Coal, gas, and oil	9,335	1.8
Water	4,123	.8
Ice and refrigeration	10,155	2.0
Telephone and telegraph	2,842	.6
Miscellaneous processing costs	11,832	2.3
Advertising and publicity	12,634	2.4
Loss on bad debts	14,929	2.9
Miscellaneous selling costs	8,251	1.6
Miscellaneous administrative costs	5,424	1.1
Miscellaneous interest costs	11,633	2.3
Total costs	$515,812	100.0

Of considerable more interest than the question of *total* cost of distribution is the query as to the *per quart* cost of distributing milk. If the average cost per quart of both distributing and producing milk is computed, then these figures may serve as a guide in establishing fair prices at which milk should be sold to the consumer. The average cost of retailing a quart of milk has been difficult to compute exactly because total distribution costs must be prorated equitably, first, between milk, cream, and miscellaneous dairy products sold, secondly, between retail and wholesale distribution of each of these commodities, and lastly, between sales in each size and type of container in which dairy products are sold. For example it costs less to wholesale milk in cans than to deliver milk in quart bottles. Also there is less cost to retailing a given quantity of milk in one-quart bottles than in distributing the same volume in pint bottles. Thus it is necessary to allocate to each dairy product sold in each channel in each size and type of container a definite measure. These measures may best be expressed on a percentage basis in terms of the cost of retailing a quart of milk. As an example it was estimated that the cost of distributing one pint of milk retail was 85 per cent as much as retailing one quart bottle of milk.

In determining these percentages it was not to be expected that costs would be available in sufficient detail from the books of these dealers to secure the percentages exactly. In computing these figures all available information was used including (1) estimates furnished by the dealers and others intimately connected with milk distribution, (2) similar studies made by research workers in other states,[4] and (3) information from the records kept by the four largest dealers. The final figures that were used are therefore partially based on estimates but it is believed that they make possible the computation of the distribution cost per quart of milk with a close degree of accuracy.

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[4] Marshall, John, Jr. Cost of Distributing Fluid Milk, Cream, and Other Dairy Products in the Los Angeles Sales Area—Twenty-one Distributors Los Angeles Sales Area for the Year 1933. Division of Markets, Cal. State Dept. of Agr. A mimeographed report. July 5, 1934.

Spencer, Leland. Various mimeographed reports of costs and profit of milk dealers in New York State as reported in mimeographed form to the New York State Milk Control Board in 1934.

The average cost of distributing a quart of milk retail as determined in this study of the four largest Portland dealers was 5.45 cents per quart. This was slightly higher than the retail price spread of 5.41 cents per quart permitted by the State Milk Control Board, effective November 1, 1935, for milk containing 4.1 per cent butterfat. (If dealers had sold milk containing 3.7 per cent butterfat instead of 4.1 per cent, their retail spread would have been increased to 5.75 cents a quart—the difference between the retail price of 12 cents and the producer's price of 6.25 cents.) A comparison between the cost of distribution and the spread allowed on a quart bottle of milk retailed, however, is not necessarily a true indicator of the extent of the profit or loss on all dairy products sold. For example, dealers might lose on wholesale milk more than on retail milk, and then there is also the question of profit or loss on cream and miscellaneous dairy products sold.

The total cost of distribution for all milk sold, both retail and wholesale, either in bottles or in cans, was 5.15 cents per quart. The total gross returns on this milk, based on Milk Control Board prices at Portland, effective November 1, 1935, averaged 4.65 cents per quart. Thus on all milk sold by the four larger Portland dealers, there was a loss of approximately one-half cent per quart. To offset this loss on milk sales these dealers need to (1) obtain relatively higher returns from the sale of cream and other dairy products, (2) receive a wider spread by the State Milk Control Board, (3) reduce special services given in the distribution of milk or otherwise reduce costs, or (4) reduce the butterfat content of the milk sold. The latter is an important factor. If a dealer sells 4.0 per cent milk instead of 3.7 per cent milk, his margin is increased one-fourth cent per quart, or if he sells 4.3 per cent milk instead of 3.7 per cent milk, his margin is increased one-half cent per quart.

GRASSLAND IMPROVEMENT

PERMANENT PASTURES. Delmar S. Fink. The importance of productive pastures as a part of the second largest industry in the state, dairy farming, has recently been given much emphasis. In view of the importance of pastures and meadows detailed grassland experiments are being initiated, designed to aid in the making of grassland improvement.

A series of fertility plot trials were constructed during the past summer, to gain much needed information in regard to the response obtained on grassland by the use of fertilizers carrying the major plant food elements. These trials are being conducted on five distinctly different soil types, and will be carried over a period of three to five years. They are located on the farms of E. G. Rowe, Newport; M. H. Bailey, Oakland; F. F. Goss, Auburn; William Gould, Farmington; and E. Hilton, Anson. The trials as yet have not provided sufficient information for making definite pasture recommendations. The following observations may be reported. Under all conditions a very distinct response was obtained from the addition of the major plant food elements. There was an excellent response on all farms to nitrogen on permanent pastures. A point of significance noted in this work to date is that pasture land on all farms was found to be equally as deficient in potash as in phosphorus. Phosphate treatment alone made little improvement in the turf, while a treatment of phosphate and potash made an excellent improvement.

GREENHOUSE INVESTIGATIONS. Delmar S. Fink. Greenhouse tests are being conducted on representative soil samples from the various pasture field plots to determine, under controlled conditions, exactly what is happening to fertilizer applied to these soils. Additional greenhouse tests are being conducted on these soils to determine the extent of any minor plant food deficiencies.

PRACTICAL FIELD TRIALS. Delmar S. Fink. At Highmoor Farm, Monmouth, all promising fertilizer treatments, as shown by the plot tests, as well as any promising pasture improvement principles, will be put to practical test. In this work yields will be determined by the actual amount of milk produced and cow days of pasture obtained.

TIMOTHY MEADOWS. Delmar S. Fink. The importance of making a good dairy cow hay out of timothy has also been strongly emphasized. A research program in this field is very important in Maine for two reasons: first, there is no question that real good timothy hay makes for more efficient milk production, and second, practically all of the hay fed dairy cattle in Maine is timothy. The key factors in producing a better quality timothy hay are proper fertilization and early cutting. The latter factor has been so well established that little experimental work is warranted in that con-

nection. Additional information is needed, however, in regard to proper fertilization. To gain this information plot trials were conducted on three different timothy meadows during the past summer. The results for the first year show that five dollars worth of nitrogen produced 1,742 pounds of additional hay, eight dollars worth of nitrogen produced 2,168 pounds additional hay, and those plots receiving eight dollars worth of complete fertilizer (2-1-1 ratio) produced 2,553 pounds additional hay. These figures would indicate that if a farmer intends to invest five dollars or less in fertilizer he might better stay by a straight nitrogen program. If, however, he plans on investing eight dollars or more, then he should be thinking in terms of a complete fertilizer.

ANIMAL BREEDING AND NUTRITION

A STUDY OF THE RELATION OF MAN AND ANIMALS TO THE ENVIRONMENT.[5] W. Franklin Dove. All projects from the Department of Animal Biology as outlined in 1926 and as added to since that date have had one common unifying principle, namely, that each project was designed as a study of some phase of the *relation of man and animals to the environment.* In the *first* place *this study is distinguished by its treatment of an individual science as an integration of all related sciences and not merely as a separate science.* A major division of the study has been an investigation of what is called a *"climate-soil-plant-animal-man"* network. From recorded data in the fields of geology, meteorology, soil and plant science (and, as will be noted later, from well authenticated observations of economic and psychosocial phenomena) those facts which might bear a significant relationship to the problem of food-getting in both animals and man were carefully compiled and analyzed.[6] In studying this network the animal was considered the point of concentration of converging factors. This was done for three rea-

[5] The present report is a condensed statement of pertinent sections taken from a larger detailed work documented with the factual material on the same subject soon to appear in print in which a combination of regional survey, statistical analysis, and experimental procedure is applied to the hereditary-environmental-socioeconomic aspects of food-getting.

[6] A preliminary analysis of this interrelationship has been presented in Maine Agricultural Experiment Station Bulletin 375.

sons: (a) because the animal, dependent as he is on plant food, serves as an indicator of elements essential to animal health which may be lacking in plant foods and consequently in the soil and climate of the region; (b) because the animal also serves, in many respects, as an indicator of human needs in the same environment; (c) because, from the human standpoint, most of the classes of domesticated animals (livestock) attain value only in so far as they are able to fulfill the function of supplying some of the most important food nutrients required by human beings.

The *second* feature of this study and the feature which characterizes the method of actual experimentation is the analysis of the problem of food-getting in terms of individual preference for food.[7] As has been pointed out, the choice of food made by different individuals varies not only with their differences in hereditary potentialities but with the climate and environment, with variations in the plant foods grown on different soils, with the psychosocial influences of habits, imitation and greed, with economic factors related to the abundance or unavailability of food. These experiments on individual differences hold, quite obviously, an intimate relation to the statistical study of the "climate-soil-plant-animal-man" network previously described.

The *third* characteristic that distinguishes this approach is the consideration in both the statistical and the experimental phases, of *psychosocial and economic pressures* related to food getting. These pressures, expressed as they are for example through food habits and through the availability or non-availability of foods, are just as necessary to the production of superior individuals free from nutritional deficiency diseases as is fertile soil or "instinctive" wisdom in the choice of food.

The problem of food getting has, then, been approached from three points of view—that of the network of influencing factors, that of individual differences in reaction toward food, and that of social and economic influences. Such an analysis is bound to give a means of judging the important lacks in the food production program of the region. It furnishes a critique of agriculture from the point of view of animal and human biology. It does more than that,

[7] The results of experiments on the problem of food preference have been analyzed in detail in the American Naturalist, Vol. 69:499-544, Sept., Oct., 1935.

it secures information which indicates with definiteness, the form that research can take if it would provide a remedy for the situation. In other words, *the final criterion of a research project would be placed in terms of the physiological requirements of man and his livestock as they must exist in the geographical area under analysis.*

"Climate-Soil-Plant-Animal-Man" Interrelationship. Man and animal are so intimately related to the environment that one cannot with justice study the food demands of the animal (or man) without an exact knowledge of all factors of the environment, both physical and social, which may contribute to these demands. It has been shown, for instance, in the course of these experiments that a nutritional deficiency may be caused at different times by any one of many different factors. For instance, a deficiency related to calcium assimilation common to the livestock and the people of the region of Maine may be due to (1) climatic factors (lack of ultraviolet rays of the sun, either actual or caused by excessive cloudiness), (2) infertile soil, either naturally lacking in available calcium or depleted by cropping of its fertility with the consequently inferior mineral or vitamin content of the crops and forages, (3) hereditary factors (skin or hair or coat color), (4) faulty food habits, (5) lack of easy access to the preventive foods or minerals, (6) socioecomonic factors such as those related to economic status or to profit interests.

Each nutritional deficiency disease has its own characteristic group of possible causes. Furthermore the same deficiency disease may be caused by a different set of factors in one community than in another adjacent to it. With some nutritional deficiency diseases the causative agent will be found as a simple neglect of a proper balance of nutrients readily available. Once the trouble is diagnosed through experimental methods and attention is directed to this fact the cure can be, from then on, permanent. But frequently it happens that biological assay of this type cannot solve the difficulty because the preventive factor is not available or because personal prejudice interferes with the adoption of the preventive. Under such circumstances biological experimentation is nearly useless. Thus it is evident that an immense gulf may exist between fundamental research and actual human utilization and that when human utilization is impossible the fundamental research loses point.

In order that the proper interpretation be secured in the analysis of such biological problems as nutritional deficiency diseases, with

their great importance to agriculture and to human welfare, and in order that the results of experimentation may be actually usable as a permanent preventive, experiments have been paralleled with a thorough analysis of all existent data of the state that bear on climate, soil, plants, animals, and man. An attempt has been made to extract from that information those facts which might give clues both to an understanding of the physiological demands of the people and the livestock in the region and to the nature of the factors which prevent these physiological demands from being satisfied.[8]

It has been possible to extract from such data information of exceedingly great value. From meteorological data on temperature variability, precipitation, sunlight, etc., information has been secured which indicates the predisposing of the Maine inhabitants to respiratory and structural defects. From geological and soil studies certain areas deficient in calcium, magnesium, iron, and generally infertile have been localized. From studies in geographic botany and from economic data on plant production, indications have been noted of vitamin A and C deficiencies. Questionnaires on animal health, war records on defects in drafted men, and economic statistics have shown clearly the intimate relation of man and animals to their total environment and furthermore have demonstrated that when physical environment is not the causative agent certain powerful psychosocial and economic factors may bring about the same deficiencies.

From this type of information it has been possible to devise a relatively accurate method of predicting the presence of the most prevalent deficiency diseases. The information has provided also a guide to the most adequate methods of preventing deficiency diseases, some of the methods requiring new information from biological experimentation, some the dissemination of information already available, and some an economic readjustment through group action.

The principal defects among the inhabitants of Maine which must be kept in mind in the continuation of present studies and in the formulation of further study are as follows:

(1) Respiratory defects
(2) Defects of the heart and blood vascular system
(3) Bone and structural defects
(4) Certain congenital and sensory defects

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[8] During the last three years students through the ERA and the NYA have furnished welcome assistance in these tabulations.

And among the livestock are:

(1) Bone and structural defects, fractures (cattle); carinal curvature (domestic fowl)
(2) Breeding difficulties (cattle); hatchability difficulties (domestic fowl)
(3) Depraved appetites (cattle); cannibalism (domestic fowl)
(4) Congenital defects (cattle); embryonic teratas (domestic fowl)

Not all of the defects listed can be traced, as yet, to nutritional origin. Nevertheless, each defect is considered a potential part of the problem. The vitamins and minerals which have been considered as subjects for this study, and which are now being studied experimentally, may be listed as follows in order of their relative importance to the state's welfare.

Vitamins D, A, C, G, B
Minerals Ca, P, Fe, Cu, Mg

New deficiencies not as yet defined have been noted, and new advitants have been recognized. Therefore, as information is secured to indicate deficiencies of importance, the plan of investigation will be modified or extended. Certain phases of the study are summarized in greater detail in the following paragraphs.

INFORMATION ON INHABITANTS. The information on defects in drafted men though of great value was lacking in some respects since the records were taken on young men reared almost entirely in the days before vitamins were widely recognized.

In 1933 a project was outlined to secure physical records on the present child generation and in order to secure food habit studies to parallel those which were in progress with experimental animals. The project was designed to cover a sample of each section of the state in order that the regional and local variations so intimately related to differences in climate, soil, and native foods, and to social and economic conditions could be included as a part of the study. In the meantime physical examination records of freshman students at the University of Maine were used as a source of data revealing at least the present physical condition of representative samples from all parts of the state. Later, in 1934, the Department of Home Economics adopted the essential features of this method of attack to a study of food habits of school children in three typical sections

of the state. From studies on the freshmen and the separate studies on school children, information has been and will be secured which should be of great value in diagnosing the causes of deficiencies and in suggesting alterations in the remedial methods outlined.

NUTRITIONAL DEFICIENCY DISEASES OF DAIRY CATTLE. During the past year additional information was sought on the nature of the deficiencies most prevalent in the dairy cattle of the state.

In 1934 a questionnaire was sent out to the purebred dairy cattle breeders. The frequency of nutritional deficiency diseases occurring in the dairy cattle of the region is evident from the following tabulation:

FREQUENCY IN OCCURRENCE OF DEFICIENCY DISEASES (OR THEIR SIGNS) AMONG MAINE DAIRY CATTLE. 1934

(Based on 200 reports—20 per cent returns)

Characteristic	Rate of Occurrence
Depraved appetite	34 per cent of the farms
Breeding trouble	70 per cent of the farms
Broken or fractured bones	23 per cent of the farms
Lameness, stiffness, sore feet	59 per cent of the farms

An analysis of the feeding methods indicates a general lack in the feeding of minerals and high-vitamin feeds. The absence throughout most of the state of home-grown concentrates for dairy cattle requires that feeds be imported into the state. The resulting high price of feeds, especially of protein and vitamin feeds, tends to encourage a low rate of feeding and consequently a low plane of nutrition. A large part of the forages fed are non-leguminous. Pasture lands and crop lands have been cropped for many decades without an equivalent return in fertilizer. Furthermore, a large percentage of the pasture lands of the state are wooded. Woods not only prevent the grazing animal and the plant from making the optimum utilization of calcium, but also interfere with fertilization and crop rotation and prevent intensive production methods. Only 11.49 per cent of the pasture lands are plowable (1935 U. S. Census figures). When we add to these facts the additional indications (from drainage water of southern Maine) of a calcium and magnesium deficiency in soil water which is correlated with low mineral content of the plant we begin to recognize the intricate nature of

the problem of deficiency diseases and to realize that biological analysis alone will not correct the situation.

FIG. 28. The condition of an animal is closely related to the climate, soil, and pasture land. The accompanying photograph shows a typical example of the intimate interrelation between climate, soil, plant, and animal. According to the census returns of 1935, Maine had 957,843 acres of wooded, unplowable pasture land. Only 11.49 per cent of the pasture land was plowable. In large numbers of excellent cattle, many of them purebred, which are subjected to such conditions, under-nourishment or "chronic deficiency" is the result. The corrective lies both in pasture improvement (through varietal selection and fertilization) and in research into methods of supplementing these pastures and hay crops with vitamins and minerals and a balance of nutrients secured from the concentrate part of the ration. Pasture improvement and selection for varieties of pasture plants high in the vitamins required in the region will improve the well being of livestock considerably, but pasture and hay crop improvement alone will not supply the barn-kept animal throughout the long winter months with the highly important vitamin D.

As has been said before, some deficiency diseases are common in the livestock of an entire state or geographical region of the country, others are characteristic of the livestock of a particular locality

or even of a single farm. The great variation existent in southern Maine soil from farm to farm, as well as the existence of other conditions such as the effects of climate, sunlight, varieties of pasture crops, availability of concentrates, and variety of animal, makes a blanket judgment of the causes of the defects in any particular herd a difficult matter. Furthermore, study must be made of animals showing defects which, as far as the writer is aware, have never been diagnosed. The unique composite of conditions peculiar to a locality perhaps make such defects unique.

FIG. 29. Some pasture lands are plowable, well-fertilized and prosperous. This pasture, only six miles from the one shown in Figure 28, carries a more thrifty herd of cattle.

The conclusion can be drawn that nutritional deficiency diseases are of great concern in Maine's dairy industry because such deficiencies result finally in a low and inefficient plane of production. The conditions causing such deficiencies must be corrected before any permanent breed improvement will prove successful, inasmuch as the high-producing animal requires a better balance

of nutrients, minerals, and vitamins than does the low and inefficient producer. The corrective lies both in pasture improvement and in research into methods of supplementing these pastures and hay crops with mineral and vitamin concentrates. Neither pasture improvement nor nutritional research alone will solve the problem permanently.

Certain nutritional correctives are already clear. Bone meal can be added to rations or permitted for free selection to supply calcium and phosphorus. Or calcium and phosphorus may be secured from vacuum-dried white fish meal. Experiments conducted during the year on the biological assay of Maine vacuum-dried fishery products continue to show that in addition to calcium and phosphorus these readily accessible and cheap protein foods also contain appreciable amounts of vitamin D (as reported in Bulletin 375) and furthermore that they contain significant amounts of vitamin A. Since white fish is a Maine product, available to Maine livestock feeders at low protein prices minus high freight rates, and since it supplies vitamins A and D and the minerals calcium and phosphorus, the four factors which are apparently most needed for supplementing the foods now available, its value as a permanent addition to livestock rations is indisputable.

NUTRITIONAL DEFICIENCY DISEASES IN THE DOMESTIC FOWL. As has been noted in a foregoing table, there are a number of nutritional deficiency diseases which appear in domestic fowl of the region. Some of the most serious deficiencies, however, may be remedied by proper methods of rationing. The necessity for a constant supply of vitamin D and calcium for both growing chicks and mature birds is evident, but tendencies toward over-economy frequently tempt the feeder to compound rations containing less than the minimum of the expensive advitants.

Nutritional experiments conducted during the year continue to show that the vacuum-dried white fish and herring from the Maine coast contain vitamin D, calcium, and phosphorus. Since these foods can be purchased by Maine farmers at prices far below the current prices of proteins which do not contain vitamin D (and other important elements that fish contain) there is no necessary economic limiting factor.

The tendency to eliminate other high-priced ingredients such as dried milk from the standard poultry rations also has made

trouble. Experiments made in this laboratory on limited rations show that although dried skim milk may not appear essential for growth from 3 to 11 weeks of age, nevertheless a well-balanced ration for baby chicks should contain dried skim milk in order to ensure freedom from deficiencies.

The problems in poultry feeding are in so many respects similar to those in dairy feeding that the nutritional experiments now in progress with chicks serve both industries. As a precaution,

FIG. 30. The lack of milk in the chick's ration may bring about leg defects as shown above. Milk, either fresh or dried, contains minerals and vitamins that are usually indispensable. The high price of milk sometimes tempts the feeder to eliminate milk from the ration.

The above chick had the opportunity to select his food from a potential balance of nutrients, with the exception that dried milk was not available. As a result he grew normally until about the fifth week and then became crippled. Individuals permitted to choose from the same group of foods with dried skim milk as an additional food from which to choose, grew normally except for a few who, upon segregation, were found not to be consuming dried skim milk.

This is an instance of a condition in which the curative factor, though known, might not be applied because of economic factors.

however, the biological assays for new supplies of vitamins and minerals are being carried out on chicks, rats, and calves, in that way ensuring the adjustment of the information to the entire livestock industry.

The Nutritive Instincts and Food Selection. The study of the food preferences of individuals differing from each other individually or genetically and placed in different environmental situations was indicated in the introduction as a necessary part of the larger study of food-getting. In this analysis of individual differences in the nutritive instincts and of the causes and effects of variations in the selection of food, a biological assay technic has been developed in order to measure the nutritive value of foods under a complex of varying genetic and environmental factors. This "individuated assay technic" consists in brief,[9] in a (bi-weekly) shifting and resorting of individuals according to their abilities to select the foods required for the particular form or function under analysis. The hypothesis is that when all modifying factors are under control, the food preferences of the *individual type* can be used to measure the quantity and quality of food demanded for the expression of that particular individual type.

Both the superior and the inferior animal indicate their food choices and it is discovered that observations on the food choice of superior individuals can teach one as much about proper nutrition as can observations on the food choice of the deficient.

This individuated assay technic has made possible the analysis of various problems in the relation of the individual to his food that could not have been secured by any other technic. By means of such individuated assays, genetic factors for physiological functions can be disassociated from purely nutritional influences. The food required, the order in which foods are consumed, and the correct combinations of foods for optimum growth, productivity, and longevity may be ascertained. A study of the complementary action of foods is made an actuality. Quantity and quality of food can be analyzed in a mathematically integrated system. A knowledge of the likes and dislikes of animals for certain foods proves of great assistance in the formulation of rations and mixed foods agreeable to the appetite.

[9] American Naturalist, 69:476. 1935.

FIG. 31. Both chicks were hatched at the same time. One weighs 290 grams, the other 964 grams. Under controlled laboratory conditions both chicks had an equal opportunity to choose from the same seven different foods. The small slow-growing chicks chose entirely different ratios of foods than did the large fast-growing chicks. The rations selected by the slow-growers, when fed to other chicks, produced slow growth rate, while the rations selected by fast growers produced fast growth rate. When a large number of chicks are grouped in an ascending series according to their future predicted growth rate there is found to exist a functional relationship between growth rate and the ratios of foods consumed. By means of this "individuated assay" it is possible to discover the rations required for the optimum rate of growth, and the most efficient rate of growth, and to discover the causes of certain nutritional deficiency diseases.

A complete account of this technic and its actual as well as potential contributions can be found in the American Naturalist, volume 69, pages 469-544, September, October, 1935.

FOOD PREFERENCE AS A GUIDE IN NUTRITION STUDIES. Modern nutrition has brought into common acceptance the idea that in devising rations for animals and diets for human beings we must base our formulas upon chemical composition and vitamin assay. The factor of palatability has at times been neglected. By taking

definite stock of palatability and food preference, it has been found that some foods rated as of high nutritive value from the standpoint of all biochemical tests will be refused by the animal permitted free access to the food.

An example of a nutritious food which is unpalatable is shown by the results of tests on alfalfa leaf meal. After the first few pecks, day old chicks refuse to consume this widely used food product in its undiluted and concentrated form. Large numbers of chicks were permitted free access to this food for eleven weeks without a record of consumption.[10] When given alfalfa leaf meal as the sole food they preferred to starve. And yet this food is widely used as an important ingredient in livestock and poultry mixed rations and even in prepared baby foods. When alfalfa leaf meal is added to the mixed ration the ration is consumed with no apparent protest. And yet experiments conducted during the past year show that the *quantity* of food consumed decreased when a certain distasteful ingredient was added. It may be necessary to select alfalfa varieties on the basis of palatability to the consuming animal.

Tests conducted during the year by means of the individuated assay technic show that different brands of the same foods have different preference rate. For instance, "feeding oatmeal" was consumed at a low rate and this phenomenon was accompanied by a low rate of consumption of all other foods given for free selection. Together with the low rate of food consumption was a general unthriftiness. Subsequent tests on three different brands of "feeding oatmeal" showed that each brand had its own characteristic preference rate.

FOOD PREFERENCE OF CHICKS FOR THREE DIFFERENT BRANDS OF FEEDING OATMEAL
(From day of hatching to one week of age)

Brand of feeding oatmeal	Taste of food	Number of chicks in test	Preference for feeding oatmeal (per cent of total food)	Amount of food eaten (n=50)	Gain in weight (n=50)	Mortality
A	Sweet	50	21.35	4661 gr.	829	0
B	Bitter	50	3.52	4300 gr.	565	3
C	—	50	11.65	4310 gr.	742	2

[10] American Naturalist, 69:492. 1935.

Furthermore, when chicks were given mixtures of foods containing large percentages of low-preference feeding oatmeal, they refused to consume the quantities expected for the age and became generally unthrifty. The factor responsible for this dislike for certain brands of feeding oatmeal (though possibly mustard seed) has not been determined. Fortunately, however, it has been observed that by tasting samples one can separate out this "bitter" form of feeding oatmeal from the "sweet" feeding oatmeal.

These two foods, alfalfa leaf meal and feeding oatmeal, two common ingredients in the standard rations of livestock and poultry, are sometimes not palatable to them (at least not to chicks). The fortuitous inclusion of such unpalatable feeds in mixed commercial rations may be one of the causes of the "poisoned food" so frequently reported by feeders in which poisons are seldom found.

Psychosocial and Economic Factors in Nutrition.[11] As stated in the introduction, economic and social factors including psychological factors may be responsible for the occurrence of nutritional deficiencies within a region. Hence social and economic regulation may be required in order to prevent permanently the continual recurrence of the deficient conditions of the nutrient environment. Psychological, social, and economic problems are not generally considered within the scope of the biology of nutrition.[12] The biologist should be able to discern the nature of the cause of mal-conditions and to perceive the correct remedy even though the remedy

FIG. 32. Individuals differ in the ability to choose food wisely. All three calves had free access to the same series of foods. Number A, a year older than the other two calves, was able to choose the food combinations required for superior conditions throughout two winters. Calf number B was less successful than A, but calf number C was unable to choose the foods required to prevent an extreme form of nutritional disturbance of a rachitic nature. However, by the following fall even calf number A succumbed to the lack of ultra-violet rays, a climatic deficiency to which he was powerless to adjust himself and came to appear like calf B. By means of proper mineral and vitamin additions to his ration he is being brought back to his former superior physical condition.

[11] Some of the social and economic phases of this nutritional problem have already been treated in American Naturalist, 69:469-544. 1935.

[12] The psychologist, sociologist, and economist, rarely, if ever, treat the problem of food-getting as a problem of nutrition.

A
B
C

may be in terms of an economic readjustment. Furthermore, the biologist should be expected to direct the action required to legislate the condition out of existence, if such action is necessary, since he alone is sufficiently aware of the seriousness of situations which usually come to be tolerated by others as "normal."

In the same way that many research workers tried for decades to solve the negative calcium balance by the then current biological assay methods but failed to find the solution until some one worker looked to the sun for the answer, so it appears now that many biological problems of both livestock and the people cannot be solved until someone looks toward psychological or socioeconomic factors for the solution.

From a study of the data secured in the "climate-soil-plant-animal-man" interrelationships it was postulated that in Maine vitamin D, calcium and phosphorus deficiencies are of major importance and that possibly the lack of iron (and other anti-anemic factors) and vitamin A deficiencies are of second and third importance. From the same physical and economic data there was predicted in 1932 the existence of vitamin C deficiencies within the area. The factors related to vitamin D, calcium and phosphorus, though in part dependent upon economic adjustments, were found to be largely a problem of nutrition. On the other hand, lack of vitamins A and C was found to be closely tied up with factors of social and economic nature (group coöperative production methods) and with psychological factors (food habits and cooking habits). Once this difference was recognized it was possible to plan an experimental program which would surround as many of these extra-biological influences as possible. In order to meet the situation experimentally, a project was developed to select varieties of fruits and vegetables (suitable to the region and climate), which are not only high in the two vitamins required but are suitable to the food and cooking habits of the region.

This project has set up as its objective a so-called "vitamin sieve"—a vitamin selection to precede all other selections of seedlings, rootstocks, or progeny of crosses. The selection sought is based upon consideration for the prevailing economic and psychosocial conditions to be met. It is recognized that an indiscriminate application of this vitamin selection to all fruits and vegetables might be absurd. There are other criteria of food value besides that

of vitamin value. Sometimes mere "fancy" has sufficient psychological interconnections to stimulate nutrition even though the product is totally lacking in nutritive value. But with rational discrimination it should be possible to guide such selections so that the nutritional demands of the group can be satisfied and the results of experimentation made humanly useful.

Both vitamins A and C are under analysis. While study on vitamin A is as necessary for animals as for human beings, vitamin C is considered of less importance to the problems of livestock. However, recent work indicates that vitamin C may be of greater importance to animals than has been heretofore suspected. Consequently varietal selections for vitamin C, as well as for vitamin A, will facilitate two processes—animal feeding and human feeding.

As stated recently, "After a taste for such foods (vitamin rich) has been developed and made relatively permanent through habit, the necessity for an appeal to reason for positive vitamin and mineral demand might well be discarded, since the increased availability would gradually foster, through habit, a natural demand for the advitants of survival value. Furthermore, such an abundance of and easy access to vitaminized (natural) foods would prevent the harmful psychological complex known as 'food worries,' induced in the present generation by the necessity for retraining in food habits."[13]

SELECTION FOR VARIETIES OF APPLES HIGH IN VITAMIN C. W. Franklin Dove and Elizabeth F. Murphy. Since the apple is the premier fruit crop in this non-citrus area, and since of the various fruit and vegetable products of the area the apple is the principal one consumed raw and therefore is free from the ruinous effects which faulty (high temperature, long interval) cooking habits exert upon a heat labile vitamin, the apple is the logical first subject for varietal selections of this sort. In an attempt, however, to decrease the generation interval from the required 12 or 15 years to a reasonable working limit of a year or two, experiments have been carried out during the past year to find some part of the young seedling such as leaf, stem, root, or the sap, which might also be an indicator of the vitamin content of the fruit that would be borne many years later. The results show[14] that the

[13] American Naturalist, 69:525. 1935.

[14] Science (in press). 1936.

leaves of the low vitamin C McIntosh apple contain on the average lower concentrations of ascorbic acid per milligram of leaves than do the leaves of the high vitamin C Northern Spy. These results show that leaf and fruit of producing trees are intimately related in their vitamin C content.

The foregoing results were secured on leaves from trees bearing fruit. Further tests are to be made in order to determine the earliest age at which these vitamin differences in the leaves become manifest, and then to study the genetic phases of the problem as they are related to the production of new varieties or to the infusion of vitamin C-forming ability into those varieties which have trade preference but which are now known as poor in vitamin C.

Since in a good season the apple crop alone from the State of Maine could produce enough vitamin C for over 400,000 more people a year by the exchange of one variety of apple for another, the importance of the problem to human welfare is manifest.

APPLES

APPLE BREEDING. Russell M. Bailey and Iva M. Burgess. Breeding work with apples is receiving considerable attention due to the need of hardy, high quality varieties in Maine. Nineteen new crosses involving Baldwin, Cortland, Delicious, Golden Delicious, Haralson, McIntosh, Scott Winter, Spy, and Starking were made last spring to provide additional material. Growth measurements of seedling populations in the nursery row have provided interesting information. Diploid varieties crossed with Wealthy appear to give populations outstanding in vigor in early years of growth at least. Seedling populations from crosses involving a triploid variety as one parent have high mortality, are very variable and have made much less than average growth. Seedlings from the McIntosh X Cortland cross are much reduced in vigor which probably can be explained by the fact that this is a back cross.

THE RELATION OF SIZE OF TREE AT TIME OF SETTING TO SIZE IN LATER YEARS. Russell M. Bailey and Iva M. Burgess. Trunk diameter measurements of approximately 1,800 apple trees have been taken over a seven- to ten-year period. This study includes trees of the McIntosh, Baldwin, Spy, Ben Davis, Delicious, and Cortland varieties. The trunk diameter at time of setting has been

correlated with that found during each year of the study. The following data obtained by averaging the correlation coefficients of several McIntosh groupings in one orchard illustrate the general trend.

CORRELATION COEFFICIENT OBTAINED BY CORRELATING 1925 DIAMETER AT TIME OF SETTING WITH DIAMETER IN LATER YEARS

1926	1927	1928	1929	1930	1931	1932	1933	1934
.8908	.7298	.6729	.5951	.5553	.5376	.5228	.4964	.5122

These data show a very rapid drop in the correlation coefficients, particularly during the first few years after setting. On the assumption that size differences in the trees at setting are largely due to inherent differences in root stock, it is evident that environmental conditions after setting in the orchard have been a more potent factor in determining size in later years than possible inherent differences in the stock at the time of setting. Measurements continued over a period of years should aid in determining if a still greater portion of the variability is due to environmental factors.

WINTER INJURY IN RELATION TO GROWTH. Russell M. Bailey and Iva M. Burgess. In one block of young trees set alternately to Baldwins and McIntosh, growth of the two varieties, as indicated by trunk diameter measurements, has been very similar over a period of years. In the summer of 1934 the Baldwin trees exhibited, in the younger limbs, symptoms of injury that occurred during the previous winter. Although there was no killing of limbs, browning of the previous year's wood was generally noted. The McIntosh showed no symptoms of injury. There was no significant difference between the varieties in trunk diameter growth in 1934, the summer following the injury, but in 1935 the McIntosh grew approximately 29 per cent more than did the Baldwins. This appears to be an example of the harmful influence of even comparatively mild injury on growth.

APPLE POLLINATION STUDIES. Russell M. Bailey and Iva M. Burgess. *Incompatibility of McIntosh Strains.* Two distinct strains of the McIntosh apple are bearing fruit in our experimental orchards. One develops a uniform solid red blush and the other has the more common striped design. The compatibility of these with

each other was tested by self pollinating each strain and reciprocally crossing them. The results are given below.

Strain	Treatment	Approximate number of flowers	Per cent flowers setting fruit	Crop on rest of tree (Open pollination)
Solid Blush	Self pollinated	280	0.36	Satisfactory
Solid Blush	Crossed with striped	360	0.28	
Striped Blush	Self pollinated	825	0.24	Satisfactory
Striped Blush	Crossed with solid	660	0.00	

From this it can be seen that the set of fruit was no better by crossing than by selfing. This information would suggest that the two strains are very closely related and that one probably originated by mutation from the other rather than by the like naming of similar seedlings.

The Stage of Flower Development in Relation to Self Incompatibility. An hypothesis has been advanced that in some species of plants, self incompatibility may be due to a chemical substance secreted in the stylar tissue at the time of flower opening which tends to inhibit the growth of pollen from the same variety. To test this with the apple the following experiment was conducted: McIntosh and Wealthy flowers were self pollinated when in the following stages of development: (1) very early pink bud, (2) pink bud, (3) flowers green, and (4) petals fallen. Approximately 400 flowers were utilized when in each stage. Pollen for the early stages was obtained by forcing buds for a few days in a warm room. Counts of fruit set indicated that the most successful selfing was done at the time of full bloom; but, in every case the percentage of set was very small. In connection with this study, pollen of McIntosh and Wealthy was germinated on a series of agar plates that included agar plus macerated stylar tissue of each variety as well as checks (2 per cent agar alone plus 5 per cent cane sugar). There appeared to be no inhibiting or stimulating action of the macerated tissue in any case. The pollen germinated well irrespective of the medium used.

APPLE STORAGE STUDIES. Russell M. Bailey and Frederick B. Chandler. Some preliminary work was done in this field in 1934.

McIntosh, Golden Delicious, and Cortland were harvested at different dates over a long picking season. In all three varieties the fruit appeared to increase in size at least until the first few days in October. For example, Golden Delicious picked on October 8th were 15 per cent larger than those picked on September 22nd. No appreciable difference was observed in rate of water loss as related to picking date although apples from very early pickings were more spongy to the touch four months after picking. Around October 1 and October 15 appeared to be the optimum picking dates for McIntosh and Golden Delicious, respectively, considering keeping quality, size, appearance, and flavor.

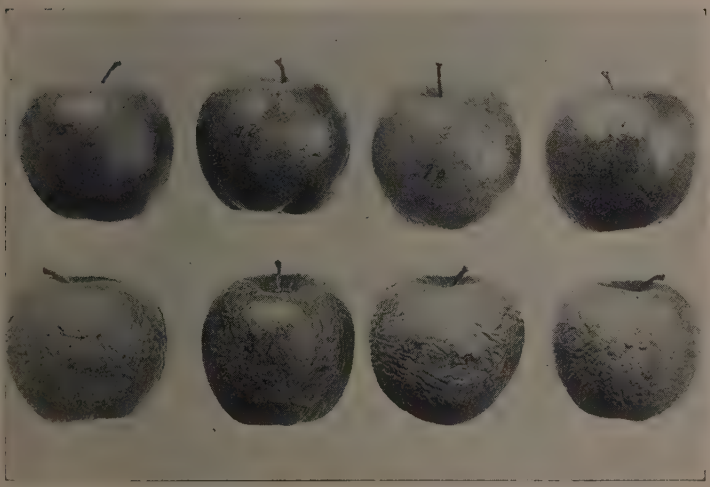

FIG. 33. Treating Golden Delicious with wax helps to prevent shriveling. Upper row—dipped in wax emulsion. Lower row—untreated.

Preliminary work concerned with various fruit treatments in relation to keeping quality was also started. A series of McIntosh and Golden Delicious treatments was started soon after harvest. This included (1) wrapping in oil paper, (2) dipping in wax emulsion (carnauba base), and (3) untreated. These were removed from cold storage in February and exposed in trays at warm room conditions for seven days. Results are given below.

Variety and Treatment		Average loss per fruit in 7 days	Average loss in per cent of untreated
		grams	
McIntosh	Untreated	5.2	100.0
	Wrapped	4.6	88.5
	Waxed	2.9	55.8
Golden Delicious (Picked Oct. 25)	Untreated	9.1	100.0
	Wrapped	8.0	87.9
	Waxed	4.4	48.3
Golden Delicious (Picked Sept. 27)	Untreated	7.0	100.0
	Wrapped	7.0	100.0
	Waxed	3.6	51.7

The waxed fruit was certainly equal in flavor, if not superior, to the untreated.

HISTOLOGICAL EVALUATION OF WINTER INJURY. F. H. Steinmetz and M. T. Hilborn. As a continuation of previous work in which it was shown that winter injury in apple trees is characterized by the killing of wood ray and wood parenchyma cells and by the plugging of the vessels, a study has been made to determine the relative numbers of killed parenchyma cells and plugged vessels which may occur before the twig or tree is beyond recovery. The data on four varieties, Baldwin, Red Astrachan, King David, and Wealthy, indicate that if approximately 50 per cent of the vessels are plugged the tree will not recover, but if only 20 per cent are plugged recovery is possible. If approximately 50 per cent of the total parenchyma cells are killed the tree will not recover, but if only 25 per cent are killed recovery is possible.

On the basis of the work of other investigators which shows (1) that hardiness does not exist in a variety as such, but must be developed, and (2) that fruitfulness, high carbohydrate and low nitrogen content are all associated with a high percentage of parenchyma it appears possible to explain on an anatomical basis why varying degrees of injury exist within a given variety in a given location.

APPLE FRUIT FLY. Frank H. Lathrop and Charles O. Dirks. During the summer of 1935 the investigation of the fruit fly problem was conducted along three lines.

(1) A study of the emergence of the flies as related to the timing of insecticide applications.

(2) A study of the behavior and dispersal of flies in bearing apple orchards.

(3) Experimental spray applications for the control of the fruit fly in commercial orchards.

The results may be discussed briefly as follows:

The emergence of flies was in general somewhat delayed as compared with the seasons of 1933 and 1934. The first emergence at Highmoor Farm occurred on July 4 and the peak was reached about July 20.

When marked flies were liberated in one tree in a bearing orchard they quickly spread to many nearby trees. The fruit flies are often difficult to see in the apple trees and as a rule it was not feasible to estimate with any degree of accuracy the amount of damage likely to occur in a commercial orchard on the basis of the numbers of flies observed in the trees. Considerable damage was done to the fruit in orchards where very few flies were observed.

For the experiments on the control of the fruit fly, two commercial orchards were selected. Neither orchard had been well sprayed for several years, and the apples were severely infested with fruit fly larvae.

Orchard No. 1 consisted of 90 trees of the Duchess and Red Astrachan varieties. The following sprays were applied:

Spray	Date	Formula (100 gallons)	
Pink	May 22	Lead arsenate	3 pounds
		Liquid-lime sulphur	2 gallons
Calyx	June 3	Same as the pink spray	
First cover	June 11	85-15 sulphur-lead arsenate dust	
Second cover	June 25	Same dust as used for first cover	
Third cover	July 20	Calcium arsenate	2 pounds
		Hydrated lime	6 pounds
		Dry lime-sulphur	6 pounds
Fourth cover	August 15	Pyrethrum-derris	1 quart

Examination of the fruits at harvest time showed the following results:

Date of examination	Variety of fruit	Percentage of fruit stung by fruit fly
August 13	Red Astrachan	14.4
August 26	Duchess	19.0

Considering the fact that during the summer of 1934 practically 100 per cent of the fruit in this orchard was infested, this is a satisfactory reduction.

Orchard No. 2 consisted of 200 trees, including Ben Davis, Stark, and McIntosh. The following sprays were applied:

Spray	Date	Formula (100 gallons)	
Pink	May 23	Lead arsenate	3 pounds
		Liquid-lime sulphur	2 gallons
Calyx	June 3	Same as the pink spray	
First cover	June 11	Lead arsenate	3 pounds
		Dry lime-sulphur	8 pounds
Second cover	June 25	Same as the first cover	
Third cover	July 22	Calcium arsenate	2 pounds
		Hydrated lime	6 pounds
		Dry lime-sulphur	6 pounds
Fourth cover	August 3	Same as the third cover	

Examination of the fruits at the beginning of the harvest showed the following results:

Date of examination	Variety of fruit	Percentage of fruit stung by fruit fly
September 12	McIntosh	2.0
October 9	Stark	11.5
October 10	Ben Davis	19.4

Considering the heavy infestation suffered by the fruit in this orchard during previous years, the treatment resulted in a satisfactory reduction of infestation.

General Discussion of Results. The experimental treatments applied resulted in satisfactory reduction of fruit-fly infestation, considering the excessive infestation that occurred during the past few years preceding the treatment.

Molasses added to the fruit fly spray in a part of each experimental orchard, showed no appreciable effect upon fruit-fly infestation of the fruit.

Pyrethrum-Derris insecticide was used for the second fruit fly spray in orchard No. 1. It is not feasible to draw conclusions from this preliminary test. Experiments with Pyrethrum and Derris will be continued.

Arsenical Residue. In order to clean up infestation by several insect pests it seemed advisable to apply a greater number of arsenical sprays than should be necessary in most commercial orchards in Maine. As a result the arsenical residue on the fruit at harvest time was dangerously near the tolerance permitted in interstate commerce.

Electric Light Traps for Combating Apple Insects. Frank H. Lathrop and Charles O. Dirks. The use of electric light traps in a block of Tolman Sweet apples at Highmoor Farm was continued during the summer of 1935, just as the experiment was conducted in 1934.[15]

During the summer of 1935, as in 1934, arsenic was applied to the entire orchard in the pink and calyx sprays. In all succeeding sprays, the arsenic was omitted from the light-trap block.

It is interesting to note that 13.7 per cent of the fruit harvested from the light-trap area was injured by insects, as compared with 11.3 per cent from the sprayed trees. It is improbable that the light traps exert much influence upon the fruit fly; it seems advisable, therefore, to eliminate the fruit fly injuries from consideration when estimating the value of light traps When the fruit fly injuries are eliminated, it is found that 3.4 per cent of the apples from the light-trap plot, and 6.3 per cent from outside were injured by insects.

The reduction in the percentage of injuries to the fruits on the light-trap plot is interesting. Attention should again be called, however, to the fact that regardless of the efficiency that may be

[15] See Maine Agr. Expt. Station Bul. 377, p. 380-381, 1934.

attained by the use of trap lights for combating certain insect pests, it will, nevertheless, be necessary to apply a regular schedule of sprays for the control of fungus diseases and fruit fly in most apple orchards in Maine. Electric light traps should therefore be regarded primarily as a possible adjunct to the spray schedule and not as a substitute for spray applications.

APPLE SCAB CONTROL. Donald Folsom. Apple scab control was studied in two orchards on Highmoor Farm, with special attention being given to the effect of spray materials on growth and yield rate.

Twenty-Two-Year McIntosh Trees. In 1935 two rows of 22-year-old McIntosh trees, 20 trees to a row, were used for a comparison of two strengths of lime sulphur. Both rows were sprayed with the Cheney equipment whereby the operator seated on top of the tank used an eight-nozzle rod. Over 800 leaves and 3,000 apples from each row were examined, and other measurements were made, with results as follows:

Strength	Full	Half
Leaves scabby	0.1%	0.6%
Leaves burned	37%	27%
Fruits scabby	0.1%	0.2%
Fruits russeted	1.4%	0.5%
Average trunk girth	55.8 cm.	55.6 cm.
Average girth increase	3.4 cm.	3.2 cm.
Fruit yield per tree	6.5 bus.	8.4 bus.

By full strength is meant one gallon of liquid or four pounds of dry lime sulphur to 50 gallons of mixture. Six applications were made during the season.

The yield rates are interesting because the average for the previous five years was nearly four bushels for the full-strength row and only three bushels for the half-strength row. It appears that reducing the lime-sulphur strength by half in 1935 was accompanied by an unexpected increase in yield rate. However, another year's comparisons are necessary because of the tendency of these trees toward alternate bearing. The yield rate was about 50 per cent greater for the four years 1927, 1929, 1931, and 1933 than for the four years 1928, 1930, 1932, and 1934, both respectively and

collectively. It seems possible that in 1936 the half-strength row will yield less than the full-strength row due to the heavier yield in 1935. Also, it is possible that in a year of greater scab severity the half-strength applications will not control scab and there will result a loss in both quality and quantity.

The yield rate in 1935 was greater for the individual tree in proportion as the tree was larger in trunk girth ($r = +0.654$ with high significance). This was especially true of the half-strength row ($r = +0.782$). This row was the only one to show significantly less girth increase as the yield was greater ($r = -0.482$). The conclusion may be drawn that the half-strength lime sulphur permitted the trees to bear more in accordance with their size but that such increase in fruit yield resulted in less growth of wood.

Young McIntosh Trees. In 1935, 362 young McIntosh trees mostly received the same spray or dust treatment for the eighth consecutive season. About 73 per cent produced fruits. Classified by size of trunk, a trunk girth of six to nine inches was generally required for the production of five to 15 pounds of fruit per tree, but at a girth of ten to eleven inches the average production was 30 to 40 pounds.

On July 30 about 2,000 leaves were examined in each series of trees, 100 leaves to a tree. The results, together with the data on fruit condition, are given in Table 24. Apparently in this moderately severe scab year the effectiveness of lime-sulphur spray was practically equalled by that of the wettable flotation sulphur spray and the bentonite sulphur dust. Considerable control was effected by lead arsenate alone, no sulphur material being used in that series.

TABLE 24

Current-Season Effects of Spray and Dust Materials on Apples

Treatment	Per cent leaves scabby	Per cent leaves burned	Per cent fruits scabby	Per cent fruits russeted
Dry lime sulphur spray	1.6	38.1	0.2—	4.2
Wettable flotation sulphur spray	2.1	2.4	0.2+	0.1
Bentonite sulphur dust	1.6	3.1	0.7	0.3
Lead arsenate spray	7.9	20.5	10.8	0.1
Nothing (checks)	22.7	4.0	68.3	0.1

The effects of consecutive years of the same kinds of spray and dust materials are shown in Table 25. Fruit production in pounds

TABLE 25

Cumulative Effects of Spray and Dust Materials on Apple Trees

Treatment	Trees		Stem circumference (cm.)		Fruits	
	Total	Per cent fruiting	Increase	Final	Total	Pounds per tree
Lime sulphur	69	58	3.54	21.93	1,252	4.54
Sulphur spray	66	85	3.71	23.15	2,299	12.13
Sulphur dust	65	83	3.63	22.60	2,425	11.25
Lead arsenate	68	74	3.81	22.74	4,025	16.43
Nothing (checks)	75	75	3.75	22.11	1,931	7.52

per tree is considerably and significantly lower in the lime-sulphur and control series than in the other three. Although associated with the greatest yield, the lead-arsenate treatment can hardly be justified after bearing has begun, because of the incompleteness of scab control by it. In spite of similarity to the other series in size of stem, the lime-sulphur series is lowest in percentage of trees fruiting and in yield per tree. This is in line with indications of the two previous years, that lime sulphur has had a retarding effect on fruiting in this experiment.

SMALL FRUITS

SMALL FRUIT VARIETY TESTS. Russell M. Bailey and Iva M. Burgess. *Strawberries.* The strawberry variety trials were conducted on about the same scale as previously reported but yields were very poor because of severe winter injury. In this year's test, Gibson appeared to be outstanding in hardiness but the variety has little else to recommend it. Aberdeen again was outstanding in plant vigor, yield, maintenance of berry size, and attractiveness. The quality, however, is only fair and the fruit is too soft for satisfactory shipping. As usual, Howard 17 (Premier) did well.

Several crosses have been made involving varieties appearing best adapted to Maine. As a result, 1,500 to 2,000 seedlings are growing to aid in the search for a better adapted late fruiting variety.

Raspberries. Data on yield and fruit characteristics were obtained from the same plantation as reported in last year's Summary Report of Progress, Bulletin 377. Results this season agree closely with those reported previously.

FIG. 34. A commercial field of strawberries in the town of Monmouth, Maine.

BLUEBERRY INVESTIGATIONS. *Pollination.* Frederick B. Chandler and Irvin C. Mason. Bees or pollinators of some kind are necessary in blueberry fields to carry the pollen from one blossom to another as in the apple and many other fruits. Data on observations of wild bee flight indicate that there are not enough bees present in most blueberry areas to get a maximum yield of fruit. Recent work with honeybees shows better fruiting of the blueberry within a radius of 150 yards from the hives than at greater distances. The results of the experiments this year show that the bees must visit the blossom within three days after it opens if a fruit is to be produced from the blossom. Therefore it is desirable to have a great number of bees in or near the blueberry field. Studies made in the field

show that it takes the majority of pollen grains four days to germinate and grow down the style of the blueberry blossom.

FIG. 35. Clusters of low-bush blueberries, about natural size.

Burning. Frederick B. Chandler and Irvin C. Mason. One of the burning experiments has been conducted for six years. It will be necessary to conduct this experiment for at least six more years to even out the difference due to seasons (sunshine, temperature, rain, etc.). The yield on the plots burned every other year surpassed the yield on the plots burned every third year. The yield on the plots burned with oil was greater in some cases and smaller

in other cases than for the plots burned with hay. The cost of burning on some pieces of land may be reduced by burning with oil instead of hay, at least if labor is considered. The Experiment Station is doing considerable testing of different kinds of burners and attempting to develop one suitable for blueberry land.

Breeding. Frederick B. Chandler, Russell M. Bailey, and Irvin C. Mason. This spring five varieties of blueberries were crossed in nine different ways. These crosses were between varieties of high-bush and between high-bush and low-bush. The crosses have given us over 800 seedlings which will be used later for testing in the field. This breeding was done in an attempt to obtain varieties of high-bush blueberries which are better adapted to Maine conditions than the ones already on the market.

FIG. 36. Fruit from a low-bush blueberry plant selected in 1928. Natural size.

Chemical Composition. Frederick B. Chandler and Irvin C. Mason. When the chemical analysis of the blueberry is compared with that for other fruits we find that blueberries have a carbohydrate and protein content higher than some of our common fruits and lower than others. The composition of blueberry ash indicates that blueberries are only a fair source of calcium, a poor source of

phosphorus, and a good source of iron. However, feeding tests have not been made to determine how much of these minerals would be assimilated in the human body.

FIG. 37. One of the most modern types of blueberry winnowing machines with a grader and picking belt. This machine removes sticks, leaves, bunches, and small berries. The berries go from the picking belt directly into quart boxes.

Weed Control. Frederick B. Chandler and Irvin C. Mason. Experiments on sweet fern have given such good control that the experiments on the cutting of the sweet fern have been discontinued, but observations are being made on the plots to see how quickly sweet fern will come back after it has been controlled. The method of eradicating sweet fern which is being recommended is cutting every year between the first of July and the middle of August. The growers who have practiced this method of control have obtained good results and are well satisfied with it.

The plots used for a test of laurel control and burned annually in the fall for three years were allowed to produce blueberries this year. The blueberry plants have been strengthened vegetatively even under this severe treatment. The laurel has been appreciably retarded but still a few plants have survived. The plots burned every two years in the fall were in fruit this year but this system does not control the laurel as well as the annual fall burning.

The alder experiment has given consistent proof that it is not economical or successful to eradicate the common alder by late cuttings. Alders have been controlled by removing the crowns or by sprinkling them with a chemical after cutting. Calcium chlorate is a very effective chemical to apply. The stumps and roots rot rapidly after this treatment. The blueberries are killed back to some extent but they soon grow back and into the rotten stump. Calcium chlorate must be handled with great care as it is a fire hazard. Common salt is another chemical which is very satisfactory to apply to the freshly cut stumps of alders and birch. Salt should be applied to all of the cut surfaces of the stump.

The bracken fern or common brake is found in some blueberry fields plentiful enough to cause a reduction in growth and fruiting of blueberry plants. Several different chemical sprays have been applied with varying success. These sprays will be continued in the future until they have been tested sufficiently to determine their value. On other plots these ferns have been pulled or cut in midsummer to determine the value of these methods for control. Two or three pullings in one year reduce the brakes nearly half but the pullings must be continued the next year or two.

This year sulfuric acid was added to the list of weed eradicators for blueberry fields. Sulfuric acid in three and a half per cent solution is very satisfactory for the control of herbaceous weeds, particularly the following: bracken fern, wild rice, sarsaparilla, bunchberry, pearly everlasting, poison ivy, rabbit foot clover, hop clover, and yellow clover. It will be at least another year before we will know the value of sulfuric acid in the control of woody weeds.

A solution consisting of one pound of sodium chlorate per gallon of water sprayed to completely cover the foliage gave satisfactory control on bush honeysuckle, milkweed, blackberry, and bunchberry. This material must be used with caution as it is a great fire hazard.

Blueberry Fruit Fly. Frank H. Lathrop and Charles O. Dirks. During the past few years the better types of blueberry lands have been rather generally dusted with calcium arsenate for the control of the blueberry fruit fly. There have been increasing numbers of complaints of injury to the foliage of the plants following the applications of the calcium arsenate dust.

Experiments were undertaken during the past summer with the following objectives in mind: (1) to determine the degree of injury that may result from the application of calcium arsenate dust; (2) to investigate the possibilities of decreasing the injury to plants by adding certain materials to the calcium arsenate dust; (3) to test non-arsenical insecticide dusts for the control of the blueberry fruit fly.

Unfortunately the summer of 1935 was one of the hottest and driest on record in Washington County, where the experimental plots were located. The blueberry foliage on all of the experimental plots, whether dusted or not, was so badly dried and scorched that few definite conclusions could be drawn from the work.

The results may be summarized briefly as follows: the addition of powdered zinc sulphate to the calcium arsenate dust appeared to reduce slightly the injury to the blueberry foliage.

Pyrethrum-derris insecticide dust, although somewhat less effective than calcium arsenate for the control of the fruit fly, appeared sufficiently promising to warrant more extensive trials. No injury to the blueberry plants was noticed where the pyrethrum-derris dust was used.

In general, calcium arsenate as applied by commercial growers gave very satisfactory control of the fruit fly during the past summer. Apparently the hot, dry weather promoted the action of the insecticide.

Blueberry Diseases. Florence L. Markin. Field studies on the control of foliage diseases of low-bush blueberries were made in certain localities in Washington County. A ten-day period of heavy rains during mid-June resulted in severe infections of the blueberry leaves by fungi. The diseased leaves fell rapidly during the dry period of late July and early August, ripening of fruit was delayed, and there was an unusual shrinkage of the fruits. Conditions were very favorable to the production of high yields on plots which had been successfully treated with fungicidal dusts, because the leaves were green, although affected by the drought, and the berries continued ripening and were plump. However, during early harvest an unprecedented period of hot weather, lasting about 10 days, shrunk and "cooked" the berries and dried the leaves on the plants. While the yield was already low on the untreated check plots, the hot weather brought down the yield of the treated plots

near to that of the untreated and reduced what promised to be very striking returns, in high yields, to very low increases.

Disease symptoms in these localities were not typical in 1935, probably because of the drought, and were confusing. The spots were less distinct and less colorful, and were marked by the lack of spore production in leaf rust and mildew and by the lack of the superficial white mycelial growth of mildew. A brown leaf spot seems to be of increasing importance and causes earlier defoliation than some other diseases.

Many farmers attribute leaf injuries of all kinds on low-bush blueberries to "arsenical injury" from the application of tri-calcium arsenate dust to control the fruit fly. Close observation will show that the so-called "arsenical injury" is usually present before the arsenical dust is applied, and that the same injury occurs in areas that have never been dusted. Leaf injuries are attributable to several causes: (1) mechanical factors, (2) insects, (3) diseases, (4) arsenic, and (5) any of the first three aggravated by the presence of the arsenical dust. The most important causes of leaf injury on low-bush blueberries in Maine are considered to be, first, fungus diseases, and, second, the aggravation of previous injuries by the arsenical dust. This is not a condemnation of the use of an arsenical dust because when it is applied as recommended, and the leaves are free from injuries from other causes many growers get little or no appreciable injury from tri-calcium arsenate. This fact suggests the desirability for the prevention of injury to the leaves, in regions where it occurs, before the arsenical dust is applied. Certain localities, in particular those directly on the ocean shore in Washington County, may experience little leaf injury from any cause. In such places copper-lime dusts cannot be expected to improve the yields greatly.

Copper-lime dust applied at certain times, and under conditions of sufficient moisture on the leaves to "stick" the dust before wind or rains can remove it, will largely prevent the leaf diseases and injuries aggravated by tri-calcium arsenate. Its purpose is to control fungus diseases of the leaves. Its fungicidal value is enhanced by the addition of tri-calcium arsenate. Not only does the arsenical increase the fungicidal value but it also kills leaf-feeding insects. Two applications of copper-lime dust give good results when applied about a month earlier than the time for tri-calcium

arsenate for fruit fly control. The time to apply copper-lime dust comes at blossom-fall and a week or ten days later. The foliage should be well covered with material at this time. The amount of copper-lime dust that gives the best results, when applied with a hand machine, is about 35 pounds per acre of a dust containing 38 per cent monohydrated copper sulphate, or about 50 pounds per acre of a dust containing 20 per cent; that is, about 10 to 13 pounds of monohydrated copper sulphate per acre for each application. Copper-lime dust is considerably heavier than the arsenical dust and consequently more will be used to cover a given area.

During 1935, using a hand duster as in past seasons, tests were continued on plots, each of one-thirty-sixth of an acre, comparing dates, numbers, and rates of applications, and kinds of materials. Some growers are equipped with power-driven dusters capable of blowing dust several hundred feet. Using a power-driven duster, mounted on a high chassis and horse drawn, plots of one acre or more were treated with materials applied at different rates.

(a) Time and number of applications. One application of a copper-lime dust made on either June 13-14 or June 24 gave better results than one application made on either June 6 or July 2. Two applications made on June 13-14 and June 24, or three applications made on June 13-14, June 24, and July 2, gave the best results. This is shown in Table 26. All yields given in this part of the report are in bushels per acre. The figures in Table 26 show the same yields for the June 13 and the June 6 plots. However, the condition of the foliage, the greater retention of leaves, and other factors, indicate that June 13 was the better date.

TABLE 26

Results from Differences in Dates and Number of Treatments with Dust A,[1] *with Average Yield of Untreated Plots 16 Bushels per Acre*

Date	Yield	Increase from dusting		Appearance of plots	Rating
		Bushels	Per cent		
June 6	20	4	25	Poor	5
June 13	20	4	25	Good	4
June 24	22	6	37.5	Very good	3
July 2	18	2	12.5	Poor	6
June 13 and 24	30	14	87.5	Second best	2
June 13 and 24 and July 2	25	9	56	Best	1

[1] Dust A consisted of monohydrated copper sulphate, tri-calcium arsenate, and hydrated lime in the proportions 20-17.5-62.5

(b) Kinds of materials. Copper-lime dusts continued to be superior to sulphur dust. Single applications of sulphur dust on either June 13 or 24 gave poor results, which are omitted from the tables. Table 27 shows the plot-yields where two applications were made on the same dates using different materials.

TABLE 27

Results of Comparison of Fungicidal Dusts Applied June 13-14 and 24, with Average Yield of Untreated Plots 16 Bushels per Acre

Dust[1]	Yield	Increase from dusting		Appearance of plots	Rating
		Bushels	Per cent		
A	30	14	87.5	Very good	2
B	24	8	50	Good	3
D	21.4	5.4	34	Excellent	1
S	21.4	5.4	34	No improvement over untreated	4

[1] Materials A, B, and D contained monobydrated copper sulphate, tri-calcium arsenate, and hydrated lime, in proportions respectively as follows: 20-17.5-62.5, 38-14-48, and 25-25-50; material S contained 87 per cent sulphur and 10 per cent tri-calcium arsenate.

TABLE 28

Results of Comparison of Rates of Application of Dust D,[1] Applied on June 16-17 and June 26 by Machine and on June 13-14 and 24 by Hand

Location	Method of application	Pounds of dust per acre per application	Yield in bushels		Increase from dusting		Appearance of plots	Rating
			Dust	No dust	Bushels	Per cent		
Ames	By machine	15	60	54	6	11	Little better than checks	4
Ames	Do	20	53	40	13	32.5	Better than checks	3
Nash	Do	20	37	36	1	3	No better than checks	5
Ames[2]	Do	35	41	27	14	52	Good	2
Nash[3]	Do	40	60.5	32	28.5	89	Excellent	1
Marston	By hand	11	25	16	9	56	Good	3
Marston	Do	20	42	16	26	163	Good to very good	1
Marston	Do	50	30	16	14	88	Good	2

[1] Dust D consisted of monohydrated copper-sulphate, tri-calcium arsenate, and hydrated lime, in the proportions 25-25-50.

[2] Harvested the day after rains broke the hot spell.

[3] Harvested four days after rains broke the hot spell and after the berries on the dusted plots had regained much of their original volume. The berries on the untreated checks did not swell to any extent after the rains. The berries began to drop five or six days after the rains.

While the yield rate with dust D was no greater than that with S, D produced better results in that the leaves were retained to the extent of 83 per cent versus 58, and the weight of good berries was increased 93 per cent versus 35. ("Good" berries means those that were unshrunken and three-sixteenth inch or greater in diameter.)

(c) Rate of application. The results of comparisons of rates of application and of machine dusting and hand dusting, using the same material, are given in Table 28.

The results show that in 1935, 20 pounds of 25 per cent copper-lime dust per acre, used in a power duster, was not sufficient. An increase of 20 bushels per acre, obtained when 35 to 40 pounds per acre was used, even under the severe drought conditions that existed, made the dusting commercially profitable.[16]

CANNING CROPS

PROGRESS IN BREEDING SWEET CORN. Russell M. Bailey and Iva M. Burgess. Major emphasis this year was placed on improvement of breeding stock and the careful testing of promising hybrids. Several hundred new selfed ears were obtained from local Golden Bantam strains to provide new breeding material.

The two top crosses which exhibited superior response last year were more thoroughly tested this season. At Highmoor Farm, they outyielded the average of four packers' Golden Bantam strains by 28.9 per cent. Fourteen other comparisons distributed over the sweet corn growing area gave an increased yield of 17.2 per cent for the hybrids. The reduced increase in the latter tests may at least in part be explained by frequent differences in maturity favoring the regular Golden Bantam. Maturity of the hybrids was found to be on the average about two days later than for the packers' strains. Measurements of ear and kernel characters showed the hybrids produced larger and longer ears and a greater percentage of 12 rowed ears. Canning tests indicate no difference in quality. Sufficient hybrid seed of these crosses was produced this season to plant about 4,000 acres for canning in 1936.

[16] Cost of dust $7.00 per hundred prepared, or $5.25 for 75 pounds per acre. Cost of home-mixed dust about half or less.

Bacterial Wilt of Corn. Florence L. Markin. Studies for the selection of resistant varieties of early sweet corn were continued in the Station greenhouse and at Highmoor Farm. The methods of inoculation and determination of yield have been described (Maine Agr. Exp. Sta. Bul. 377. 1934. p. 394). Late planting, which is unfavorable to the development of the disease, was necessitated at Highmoor Farm by heavy rains. "Mid-season" varieties such as Golden Cross Bantam failed to mature. Field inoculation did not produce as severe infection in 1935 as in 1934.

Sixty inbred lines of two Maine canners' strains of Golden Bantam were tested in the greenhouse and several of the lines, selected on the basis of the greenhouse test, were studied later in the field. The results of the two tests were in agreement.

Two hundred lots of corn were planted at Highmoor Farm, about half in duplicate. Not enough seed was available to duplicate the planting of inbred lines. The field test included 91 inbred lines from three Maine canners' strains of Golden Bantam; 48 inbred lines from a Maine canners' Crosby; five strains of Maine canners' Golden Bantam; five strains of Maine canners' Crosby; and ten crosses of inbred lines of Maine Golden Bantam. The remainder consisted of commercial varieties, new resistant hybrids, and miscellaneous samples.

Three Maine canners' strains of Golden Bantam, of the five tested, did not lose in yield from wilt under 1935 conditions. Of the lines selected from the above three strains, 15 to 25 per cent were more resistant than their parents, while an additional 30 per cent had good resistance. These strains and lines ranked well with the seven best of the 15 commercial hybrids tested for resistance, as judged by a comparison of the yields of inoculated versus check plots of the same variety, and for the most part were about two weeks earlier.

One of the ten crosses of Maine Golden Bantam was outstanding in resistance. This hybrid had previously given good results in two trials. It matured with the earliest of the Maine canners' strains of Golden Bantam, which was about two weeks earlier than all of the 15 commercial hybrids tested except one. This exception was Span X 6, which matured and yielded about the same as the resistant Maine cross.

Only one out of the five Maine canners' strains of Crosby showed fair resistance. The tested Crosby lines were from another one of the five strains. About half of the 48 Crosby inbred lines matured and three of those showed some resistance.

Experiments must be repeated under more severe conditions of infection before the new lines and crosses can be considered as sufficiently tested for resistance.

INVESTIGATIONS WITH BEANS. Russell M. Bailey and Iva M. Burgess. *Field Beans.* An experiment concerned with a study of different planting rates for Yellow Eye and Robust beans was conducted this year. The planting rates varied from 2 to 12 seeds per foot which correspond with 0.5 to 3.8 bushels per acre for the Yellow Eyes and 0.2 to 1.3 bushels per acre for the Robust pea beans. No definite conclusions can be drawn from this one season's study. It appeared, however, that in these plots the optimum planting rate for Old Fashioned Yellow Eyes was between 1.0 and 1.9 bushels per acre for highest yield and between 0.7 and 1.6 bushels per acre for the best seed size and color pattern type. The optimum rate for the Robust pea beans appeared to be between 0.51 and 0.75 bushel per acre. The seed size of the pea beans remained fairly constant regardless of planting rates.

Snap Beans. The work with snap beans consisted mainly of a variety test. Eleven new varieties of wax beans and four of green podded beans were added to the plots this year. None showed marked superiority to those previously found dependable although Alpha, a white seeded round green podded kind, is worthy of further test. It produced pods much like those of Conserva but longer and straighter. It matured with and yielded the same as Full Measure. This variety may prove of interest for canning purposes.

GARDEN CROPS

GENERAL VEGETABLE VARIETY TESTS. Russell M. Bailey and Iva M. Burgess. Among the newer varieties grown in the test plots the following appear to have promise of being adapted to Maine conditions: Viking and Emerald Standing spinach; Ohio Canner beet; Morse New Bunching, Asgrow Imperator, and Tendersweet carrots; Model parsnip; Early Yellow Globe onion; As-

grow White Seeded Wax bean; Buttercup squash; Straight 8, Longfellow (Associated Seed Growers), and National Pickling cucumbers; Lincoln tomato; Black Bountiful eggplant; King of the North pepper.

LETTUCE VARIETY AND HAY MULCH TESTS. Russell M. Bailey and Iva M. Burgess. Twenty-eight strains of New York lettuce were included in the plots this season. Seed was planted to bring the crop to maturity during the more unfavorable part of the season. None gave a highly satisfactory crop. Imperial F. (Rohnert) and New York, Stock 1137 (Ferry-Morse) were somewhat better than the others when both ability to head and freedom from tipburn were considered. The former variety, although not the best in 1934, was above the average for the plots of that season.

The use of a hay mulch on lettuce showed some very striking results. The following table gives in a brief summary the most outstanding differences obtained. These results correspond well with those obtained in 1934. One difference was noted in the size of the heads. In 1934 heads from the mulched plots were smaller than those from the check plots, whereas in 1935 the reverse was true.

TABLE 29

Lettuce Comparisons from Mulched and Unmulched Plots

	Type of heads cut				Per cent free from tipburn	Average cutting date (August)	Average cut weight of heads (pounds)	
	Failure	Soft	Fair	Hard			Fair	Hard
Check	539	178	121	28	48.3	18.0	.83	.88
Mulch	256	148	219	141	82.9	20.0	.90	.93

Failure—plants bolting to seed from a rosette.
Soft—could hardly be called "heads" because so soft and loose. Some leaves were folded over the growing part giving the appearance of a head.
Fair—rather soft heads but could be considered marketable.
Hard—firm good type heads.

TOMATOES. Russell M. Bailey and Iva M. Burgess. Several of the newly introduced varieties were included in the test plots. None of those added this season showed any great superiority over varieties previously found dependable. Penn State and Scarlet Dawn appeared to be suitable varieties for Maine conditions. Other new varieties observed were Lightning, Asteroid, Pink Heart, and Rutgers.

Work was continued on an experiment to study the effect of various methods of training for tomato plants. Results obtained were not at all conclusive. Red River, Pritchard, Lincoln, and Shirley Bonny Best were used in this study. Shirley Bonny Best appeared to give a somewhat better response than other varieties this season to heavy pruning and staking. For the other varieties, supporting the plants off the ground with a low wooden frame, was the treatment giving the best results. The use of hay mulch on tomatoes was of questionable value this season. On the whole, the early marketable crop was slightly less from the mulch plants than from the check plants.

BREEDING CUCUMBERS FOR RESISTANCE TO SCAB. Russell M. Bailey and Iva M. Burgess. This work has been continued with promising results. Several homozygous resistant selections were placed under preliminary commercial test this season. Sufficient seed (from sib matings) of the most promising was obtained for a more extensive trial in 1936. Considerable data have been accumulated to aid in a genetic study of resistance.

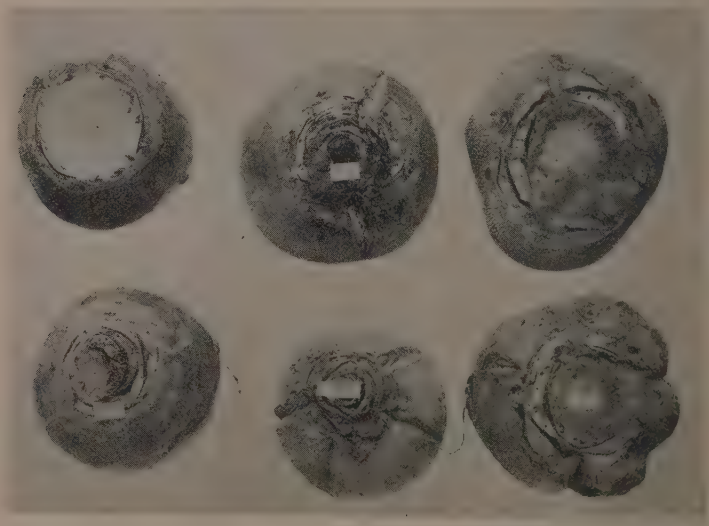

FIG. 38. The two rutabagas on the left were good while the others had water heart.

Rutabagas. Frederick B. Chandler, Joseph A. Chucka, and Irvin C. Mason. The rutabaga experiment was conducted again this year with favorable results which confirmed our data of the previous year. These results showed good control of water heart

Fig. 39. The rutabaga in the upper left hand corner was good while the others had different amounts of water heart.

with ten pounds of borax per acre. Smaller applications of borax were applied this year to determine if smaller amounts would be as efficient. Both eight and five pounds of borax per acre were not sufficient quantities to give satisfactory results. Other rare plant elements as zinc, iron, and magnesium were applied in small quantities to see if they would prevent water heart. None of these substances proved to be beneficial. Manure alone produced better rutabagas than fertilizer alone but permitted the development of a considerable amount of water heart.

The appearance of the outside of the rutabaga is of help in predicting whether or not it has water heart. If the rutabaga has

a smooth purple surface at the top of the root as those in Figure 38 on the left, it will usually be good. If it is cracked or has rough skin like the other four in the same figure, it will usually have water heart. Rutabagas which have water heart have a strong odor and a bitter taste when they are eaten raw and are usually woody after cooking.

Farmers from various parts of the state have reported trouble with water heart of rutabagas, showing that the trouble is widespread. Therefore the following table has been prepared to indicate the varying amounts of fertilizer and borax to be used to prevent water heart in rutabagas. The measures indicated should be level full. The borax and fertilizer should be well mixed and spread evenly in the row and covered with soil before the seed is planted.

TABLE 30

Rates of Fertilizer and Borax Necessary to Prevent Water Heart of Rutabagas

Length of row	Fertilizer	Borax		
feet	pounds	grams	ounces or pounds	volume
50	2.1	13.0	0.5 oz.	2 tablespoons
100	4.2	26.0	1.0 oz.	3 tablespoons
150	6.3	39.0	1.5 oz.	5 tablespoons
200	8.4	52.0	2.0 oz.	7 tablespoons
400	16.8	104.1	3.5 oz.	1 cup
700	29.4	182.1	6.5 oz.	1.5 cups
1,000	42.0	260.2	9.25 oz.	2 cups
1 acre	750.0	4,536.0	10 lbs.	

THE MEXICAN BEAN BEETLE. John H. Hawkins. The Mexican bean beetle becomes more firmly established in Maine each year. Injury to beans was severe during the past season in certain localities where the beetles had come in during previous seasons, and new areas were invaded. The spread goes on annually and the bean crop of the state is seriously threatened. If beans are to be raised, it is evident that control measures will be necessary when the pest becomes seriously destructive. Insecticides commonly used for this pest are magnesium arsenate, barium fluosilicate, and derris and pyrethrum products, all of which are effective when properly used but somewhat expensive. A study of control methods for this insect is now under way and emphasis is being placed on practical

methods. Cheaper substitutes for the more expensive materials commonly recommended are being sought. Preliminary results show certain combinations of calcium arsenate with certain spreaders or carriers to be effective, although definite recommendations for their use cannot be made until further tests are made under various weather conditions.

Arsenical Substitutes for the Control of Cabbage Worms on Cole Crops in Aroostook County. Geddes W. Simpson. The testing of a number of varieties of cabbage, cauliflower, and broccoli at Aroostook Farm offered an opportunity to experiment with rotenone dust as a substitute for arsenicals as a means of reducing injury from cabbage worms. A proprietary dust containing three-fourths per cent rotenone was compared with calcium arsenate. The rotenone dust was applied at two rates—ten and twenty pounds per acre respectively. The calcium arsenate was used at the rate of twenty pounds per acre. All applications were made with a rotary hand duster. Two applications were found to be satisfactory under the dry conditions prevailing during the past season.

Foliage injury was greatest on the plots dusted with calcium arsenate. Commercial control of the cabbage worms was obtained with two applications of the rotenone dust at the rate of but ten pounds of dust per acre. At the rate used, the rotenone cost more than the arsenate, but the difference in control obtained and the harmlessness of the rotenone dust to human beings seem to justify its use.

LAND UTILIZATION

Local Market Area Study with Emphasis Placed on Land Utilization. Charles H. Merchant and Andrew E. Watson. During the summer of 1934 a general survey was made of the size and condition of all farm buildings, kind of road on which farms were located, and other general information in five towns in Cumberland County. These towns were Baldwin, Gray, New Gloucester, Standish, and Windham. The information obtained on the size and condition of buildings gave a rather reliable index of the degree of prosperity on these farms.

In the summer of 1935, the land area in the five towns in Cumberland County was studied in considerably more detail. Lines approximately one-eighth of an inch apart each way were drawn on topographical maps. Each square represented a ten-acre tract of land. A field man traversed the area noting the crop or crops grown in each ten-acre square. No attempt was made by the field man to enter any large wooded area but the location of these areas was noted on the map and the kind of growth recorded. This procedure gave detailed information as to the cover or crop grown on all the cleared land.

In addition to information on cover, data were obtained from a representative number of farmers as to the yield of crops grown in the area and the carrying capacity of pasture land on their farms. Certain other information was obtained from town officials concerning land values and tax rates.

The material obtained in Cumberland County during the past two summers is in the process of analysis. From a study of the data it will be possible to classify the land resources in each of the five towns and to make recommendations as to the probable best future uses of the land.

FARM CREDIT IN MAINE

AGRICULTURAL CREDIT IN MAINE. Charles H. Merchant. This project was started July 1, 1934. The first summer was devoted to the collection of data from farmers who had kept farm account books in coöperation with the Extension Service and from the three production credit associations in the state. This information was supplemented by material from one of the production credit associations during the past summer. The data obtained during the past two summers provide material on such phases of the subject as credit needs of the farmers in various sections of the state, availability of credit and conditions under which credit is extended, credit ratings of farmers, and certain farm management problems including farm prices.

The information obtained from farm account books of farmers shows exactly the time of the year when funds are needed for the purchase of farm requirements. The expenses of operating the farm business on about thirty farms in Aroostook County for

each of three years 1931-34 showed that the cost of hired labor constituted 24 per cent of the total, the cost of fertilizer 30 per cent, and taxes 8 per cent. The combined cost of these three items amounted to 62 per cent of the total cash cost of operating these farms. Nearly 50 per cent of the cost of hired labor was expended during the months of September and October for the harvesting of the potato crop. Fertilizer was purchased during the spring months prior to the planting of the potato crop. In Table 31 is shown the seasonal distribution of all farm expenses on potato farms in Aroostook County. Expenses indicate the time when funds are needed to carry on the farm operations. The farmer who does not have ready cash finds it necessary to obtain credit from one or more of the available credit institutions.

TABLE 31

Seasonal Distribution of Cash Expenses on Potato Farms, Aroostook County

Month	Expenses per farm				Per cent of total
	1931-32	1932-33	1933-34	Three-year average	
July	$ 181.35	$ 126.64	$ 129.35	$ 144.74	4.02
August	193.43	141.17	98.07	139.83	3.88
September	340.62	205.10	320.75	294.36	8.17
October	489.38	423.15	488.51	470.53	13.06
November	215.60	222.75	287.49	246.93	6.85
December	266.74	202.81	228.77	231.22	6.42
January	211.17	204.93	128.35	175.64	4.87
February	228.19	166.25	181.43	191.68	5.32
March	701.93	471.83	197.22	431.34	11.97
April	662.34	617.25	306.02	504.35	13.99
May	741.90	507.09	536.19	591.91	16.41
June	241.19	169.49	144.36	181.52	5.04
Total	$4,474.34	$3,458.46	$3,041.51	$3,604.05	100.00

In operating the dairy farm business the more important items of expense are feed and grain, labor, and taxes. These three items comprised approximately 63 per cent of the total cost of operating the dairy farm business. As on the potato farms, many costs on dairy farms are seasonable.

The cost of feed and grain on poultry farms represented over 50 per cent of the total cost of the farm business. While purchases of feed for the poultry enterprise in Maine are necessary each month

of the year, a much larger quantity is bought during the growing period of the young birds.

On general farms the cost of feed, grain, and labor constituted about 44 per cent of the total cost. On these farms the livestock enterprises are important, resulting in purchases of considerable grain and feed.

The above information has pertained to production credit. Data have been obtained on mortgage credit throughout the state. The principal sources of long-term or mortgage credit in Maine are the Federal Farm Loan System (Land Bank), local banks including trust companies, individuals, fertilizer companies, and implement dealers. These sources of credit are being studied as to volume of funds loaned to farmers, interest rates charged, securities demanded, length of loans, methods of payment, and other conditions of the loans.

An attempt is being made to formulate a standard or yardstick to quickly and accurately determine the credit ratings of farmers. Such a standard should be of considerable assistance to both farmers and credit agencies for more satisfactory credit conditions.

FARM ADJUSTMENTS IN MAINE

FARM ADJUSTMENTS IN MAINE. Charles H. Merchant (Chairman of State Committee). The Maine Agricultural Experiment Station coöperated with the United States Department of Agriculture in a nation-wide project on farm adjustments. The study was started last April and the final report was submitted to Washington early in December.

The first phase of this project was the assembling of all available basic information on Maine's agriculture. The above material was supplemented with information on the general soil types and the principal types of farming in the state. The second phase of the study was to suggest adjustments in our agriculture. In suggesting the adjustments, the competitive price structure, maintenance of soil fertility, control of soil erosion, and the pursuance of good farm management practices were the principal factors considered.

The data for Maine with similar material for the other states are being analyzed and summarized at Washington, D. C.

NUTRITION OF CHILDREN IN MAINE

A Study of the Food Habits and the Nutritional Status of Children in Selected Communities in Maine. Mary M. Clayton and Marion D. Sweetman. The work begun last fall in Mars Hill, Jonesport, and Monmouth was continued throughout the winter and spring. Dietary data which were secured through home visits during the winter indicated a general deficiency of milk, fruits, and vegetables and too great a consumption of white flour products and sweets in all three towns. Also, very few children or pregnant mothers were receiving a regular source of vitamin D. In most cases the day's meals were poorly planned from a nutritive standpoint.

Physical and dental examinations were repeated in the spring. Results showed an average increase in the number of children who were 10 per cent or more underweight (for height and age) from 12.6 per cent in the fall to 14 per cent in the spring. There was also a definite decrease in capillary strength[17] in the spring; but only 4.8 per cent of the children had capillary strength low enough to be indicative of a probable deficiency of vitamin C. The Mars Hill children in general showed higher capillary strength than those in the other two towns. This is significant since most of the children in this section have only potatoes as a constant source of vitamin C during the winter months.

The assistance of Elizabeth P. Fleming, M.D., was secured for the spring examinations.

Dental examinations showed an increase in the average number of cavities per mouth from 12 in the fall to 15.7 in the spring. Practically no reparative work had been done during the winter.

This fall it was decided to continue the work in one of the three towns and Mars Hill was chosen since a sufficient number of children could be secured there in one school. The continuation of the work was undertaken as a new project, the object of which is

[17] Capillary strength was determined by the use of a test devised by Dr. Gilbert Dalldorf. The apparatus consists of a small glass cup attached to a suction pump. The cup is applied to the skin of the upper arm and various degrees of negative pressure applied for one minute. The pressure is recorded at which tiny hemorrhages appear in the skin. When hemorrhages appear at a low pressure a deficiency of vitamin C is indicated, in the absence of certain other conditions.

to discover how much improvement in the nutritive status of children can be brought about by such improvements in family diets as can be made by voluntary coöperation of families; the degree of coöperation obtained is to be judged by a study of family health and food consumption records and by the results of fall and spring health examinations of the grade school children from the families studied.

Work on this project was begun last spring when two meetings were held under the auspices of the Mars Hill Parent-Teachers' Association. At the first a talk was given by Dr. Amy Louise Hunter on "The Normal Child." Also, a summary was given of the results of the fall physical examinations and the need presented for improvement in the nutritive condition of the children. At the second meeting the value of fruits and vegetables in the diet was discussed by Dr. Clayton and suggestions for planting a vegetable garden given by Mr. Richard Dolloff, of the Aroostook County Farm Bureau. The people of the town who could not afford to buy garden seeds were urged to apply for seeds from the Federal Government. Arrangements were also made with the State FERA to open a canning center in Mars Hill.

Early this fall visits were made in the homes of the grade school children and a questionnaire filled out, giving information regarding the kinds of fruits and vegetables which had been raised and the amounts which had been canned either at home or at the canning center. People this year seemed to have had unusual success with their gardens and most of the women had canned more vegetables than usual. Considering the doubtful food value of pickles, the amount of them canned was excessive. Only a few families had been able to raise tomatoes which ripened on the vines, but many had canned those ripened in the house. The cabbage crop appears to have been small owing to destruction by worms. This is unfortunate since cabbage should be widely used in this section where fruits, tomatoes, and green vegetables are not easily available as sources of minerals and vitamins during the winter months.

Soon after school opened, health examinations were given to 206 children. These included estimates of nutrition, various measurements, hemoglobin determination, tests for vitamin A and vitamin C deficiencies, and dental examination. The dental examinations were made by Miss Dorothy Bryant, Director of Dental Hy-

giene for the State of Maine Department of Health. One hundred and forty-two of these same children were examined last year, so their records are available for comparison with those secured this year.

The data secured this fall have not yet been completely analyzed. Dental examinations showed, however, that the children's teeth are cleaner and that a good many have had dental attention since last spring.

As a part of the educational program included in the project, a series of lectures and demonstrations in nutrition and food preparation is being given for the mothers of the grade school children by Miss Lucy Farrington, Home Demonstration Agent for Aroostook County. So far five meetings have been held at which the average attendance has been 25. At each meeting mimeographed lesson sheets have been given out and this same material has been distributed to all of the mothers after each meeting, sometimes by mail and sometimes through home visits. The assistance of four local women has been secured in making these visits.

This year the teachers at the school are making a special effort to teach good food and health habits to the children and are especially emphasizing the use of fruits, vegetables, and milk in the diet. Hot lunches are to be served at the school after Christmas.

As a means of checking on the results of the educational program the mothers were recently asked to keep menus for one week and to check the foods eaten by each child examined at the school.

Three more meetings are scheduled for the mothers after Christmas and the health examinations will be repeated in the spring. It is also planned to carry on some supplementary feeding of orange juice to those children who show decreased capillary strength.

The Antiscorbutic Value of Home Canned Pickles of Various Types Used in Maine. Mary M. Clayton. The survey of food consumption habits which was recently made in three towns in Maine showed that pickles are widely used, especially in the winter. Very often home-made pickles are the only form of vegetable served at a meal except potato. It therefore seemed important to determine their antiscorbutic value and possible methods of increasing it.

Common types of pickles were made in the laboratory this summer, and this fall a number of varieties were secured from Maine housewives. These have been tested by a chemical method and found to contain much less vitamin C than the fresh vegetables from which they were made. One type which was made in the laboratory is now being tested by the biological method.

THE ECONOMIC UTILIZATION OF ELECTRICITY IN FOOD PREPARATION IN MAINE RURAL HOMES

EVALUATION OF FACTORS AFFECTING THE COST OF USING UTENSILS ON ELECTRIC HEATING UNITS. Merna M. Monroe and Pearl S. Greene. This study was planned to ascertain some of the characteristics of utensils which definitely affect cooking costs as used in the home. A study of the magnitude of these factors led to the following conclusions.

1. Area of contact between the utensil and the heating unit is the major factor in cost of operation with those surfaces which transfer heat to the utensil by conduction. Such surfaces are the solid-surface closed unit, the semi-solid-surface ring unit, and, to some extent, the tubular unit which is so constructed that only point contacts may be obtained. Apparently a negligible amount of heat is conducted from the open unit. Utensils with plane-bottom surfaces are the most economical for plane surface heating units such as the closed units, but not necessarily for those surfaces which are not plane, such as the concave surface of the ring unit. Utensils which deviate markedly up or down from a plane surface will increase operating costs on all units transferring heat by conduction. With the variety of utensils tested, the least efficient pan required 88 per cent more electrical energy to heat a given quantity of water than did the most efficient pan when used on a high thermal capacity, closed unit; 33 per cent more on a light-weight closed unit; 30 per cent more on the ring unit; and 16 per cent more on the tubular unit. None of these pans had a countersunk bottom; in commercial language they would have been called "flat-bottom" pans. An inexpensive, countersunk bottom aluminum pan required 43 per cent more watt-hours than did a plane bottom utensil when used on the high thermal capacity closed unit to heat a kilogram of water 70 degrees Centigrade, and 11 per cent additional watt-hours when

used on the ring unit. Thus a countersunk bottom pan may not be as poor choice as some "flat-bottom" pans having marked curvature of the bottom surface.

During laboratory use, changes in efficiency due to warping were found with the "flat-bottom" pressed, B. & S. gauge 12 aluminum utensils and with a cast aluminum kettle having the bottom surface machined to a thickness corresponding to a B. & S. gauge 15. Another cast aluminum kettle with a machined bottom surface equivalent to gauge 9 in thickness and the countersunk bottom aluminum saucepan showed no marked decrease in efficiency after more than 100 hours of intermittent heating of water, but the cast aluminum kettle warped after being used in dry-heat cooking. Deviation from good contact may greatly increase the operating costs of high thermal capacity solid-surface heating units. Most utensils as found on the market have neither a plane bottom surface nor are likely to retain such a surface indefinitely. The housewife is advised to consider the economy to be realized by extra investment in those types of units which are high-priced, but which, when used with the various utensils found on the market, will not give marked variations in operating cost due either to changes in contact or to ability to absorb radiant energy efficiently.

A more permanent solution to this difficulty of seeking a suitable utensil probably lies in the manufacturer or metallurgist creating an alloy which will have a negligible or no coefficient of expansion so that utensils made of this metal would permanently retain a good-contacting bottom surface. In addition the metal used in the "ideal" utensil should be suitable for cooking purposes in that it should be resistant to corrosion, insoluble in all solutions found in the kitchen, free of any tendency to absorb and retain odors, of such nature or thickness that foods will not readily scorch, easy to clean and to handle, and reasonable in cost.

Tests measuring the ratio of the quantity of boiling water evaporated to the heat input, were designed to test the thermal efficiency of the utensils on the heating units in such manner that differences in thermal capacities of both could be eliminated as a factor. These tests were begun after an equilibrium was established between heat transferred from the unit and that received by the utensil. This method did not eliminate the factor of radiation and convection losses from utensils of various sizes and ma-

terials; for pans of approximately the same diameter as the unit, these losses were assumed to be within the experimental error. These tests demonstrated that slight differences in changes of contact or in absorption of radiant energy of the same or of similar pans gave much less marked variations in efficiency than did the cold-start tests; this tendency was especially noticeable with those units transferring heat by conduction. Boiling could easily be maintained in all of the covered pans tested on low wattage of the closed, the ring, the tubular, the open, or the cone units with the exception of a tall enameled pan on the cone unit. There is no way provided to reduce the heat beyond one-fourth of the rating of the unit. Therefore, there is little practical interest in the factors which affect evaporation efficiency except in those instances wherein boiling cannot be maintained on low heat.

If electric range surface units were provided with means of obtaining a lower wattage than one-fourth of the rating, problems of "waterless" and of low-temperature cooking on these heating units, which have the necessary high wattage to quickly obtain a cooking temperature, would be of less consequence and, at the same time, operating costs would be decreased. The high wattages are needed to begin the cooking quickly, but once boiling is obtained in a well-covered utensil it may then be maintained with a relatively small quantity of heat input; all that is needed is enough to compensate for inefficient transfer of heat from the unit to the utensil and for radiation and convection losses from the sides and top of the utensil. The lowest wattage which would thus maintain boiling in a covered pan would lead to the securing of efficient heat transferring units and to the making of utensils of such size, shape, and material that losses would be at a minimum.

2. Black bottom surfaces on enameled pans do not reduce operating costs; the enameled surface itself is a good absorber of radiant energy. Black bottom surfaces on aluminum pans do not reduce operating costs when used on the closed or on the ring unit unless the pan has very poor contact, in which case the reduction is not practically significant. A black bottom surface does not absorb enough radiant energy to compensate for the loss in efficiency through poor contact. A black bottom surface on aluminum pans increases cold-start efficiency from 10 to 20 per cent when the pan is used on the open unit. This depends upon the polish of the bot-

tom of these pans. On the tubular unit an increase of 9 to 24 per cent is obtained depending again upon the polish and upon the area of contact. On a cone unit from 29 to 39 per cent. If the aluminum pans have a very dull finished bottom and if the rate paid for electrical energy is so low that a decrease in operating cost of 12 to 15 per cent will not produce a marked saving, probably the housewife need not be concerned about paying extra money for black-bottom utensils for use on the open and on the tubular units. Water evaporation tests using high wattage indicate that the black bottom surface increases the efficiency by approximately the same amount as in cold starts, and that with the tubular unit operated on low heat the increase in efficiency is approximately the same as for high heat.

3. No time is saved by using a small saucepan (just wide enough to cover the coils of a 1,000-watt open unit) on a wide, high wattage, open unit in prefernce to a smaller one, and the operating cost will be increased from 66 to 100 per cent depending upon the ratio of the wattages of the two units.

4. For ordinary cooking purposes, in which food is not to be kept hot for a long period of time without the application of heat to replace losses from the sides and top of the pan, there is little practical need of emphasizing highly polished sides and cover on aluminum utensils for use on electric heating units as they are built today. Enameled pans of the same size lose more heat by radiation than will most metals likely to be used in the making of utensils.

5. The extent to which a cover has good contact with the rim of the utensil, and not the design of the cover, determines the rate of evaporation of water at low heat inputs. At high rates of heat input, high wattage, the use of a cover may have nothing to do with the quantity of water evaporated; at lower heat inputs, such as medium or low wattage, the use of a cover determines whether a boiling temperature can be maintained, and checks evaporation slightly or greatly depending upon the rate of heat input. At wattages lower than that obtained on present-day heating units, a cover having good contact with the utensil is essential for the maintenance of a boiling temperature. The addition of clamps or weights to covers, other than those found on pressure cookers, can

be of no value unless the cover is so warped that the use of such measures flattens out the non-contacting portions of the cover.

6. The length of time during which boiling can be maintained on stored heat depends not only upon the thermal capacity of the heating unit but also upon the thermal efficiency of the utensil; an efficient pan requires less heat to be formed in the unit than does an inefficient one, hence there is less heat stored when using the efficient pan; also since the efficient pan quickly absorbs heat from the unit, the stored heat is quickly dissipated through a more rapid rate of evaporation than in an inefficient pan. The difference between efficient and inefficient pans in maintaining boiling on stored heat is of wide range on the high-thermal capacity units and of very narrow range on the low thermal capacity units.

7. Although water-heating tests indicate that triplicate sets of saucepans are cheaper to use than three single pans on three units, cooking tests demonstrate that under certain conditions the use of triplicate pans may not be an economy. A triplicate set of saucepans of sufficiently small diameter to permit being used on a low wattage unit is more economical than single-pan-single-unit cooking, but a set so wide that a high wattage unit must be employed may prove to give no reduction in operating costs. The design of triplicate sets of saucepans could be improved for use on electric heating units. As these pans are now made, the rims at the top prevent placing the pans close together to secure contact with or exposure to all of the heating surface.

For electric range cooking in which there is no economical means of reducing the heat input for foods requiring low-temperature, long-time cooking, the insulated, low-wattage underhung cookers which may constitute a part of an electric range will be more economical than "waterless" cookers which employ some artificial means to dissipate the heat so that only a small portion of the heat provided may reach the bottom of the cooker. The use of a grooved steel, heat deflector under a "waterless" cooker reduced rate of evaporation but increased the cooking time and cooking cost.

A manuscript giving the details of this study is now being prepared for publication.

THE EFFECT OF THE METHOD OF HEAT APPLICATION ON FLAVOR AND TEXTURE OF BAKED FOODS. Merna M. Monroe. Conditioning tests have been made with the two ovens to check perform-

ance; these tests demonstrated the need of certain changes in the design of ovens and these changes are now under investigation.

CHEMISTRY INVESTIGATIONS

Work of Investigations. Elmer R. Tobey. Due to a rearrangement last year to assist in the curtailment of the financial expenditures of the Station the amount of time available for work of an investigational nature was considerably reduced. The chemical work, coöperative with members of other departments in the Station, has been continued. The results of this work are incorporated in the published reports of the respective projects.

INSPECTION SERVICE

Work of Inspection Service. Elmer R. Tobey, C. Harry White, Bernie E. Plummer, Jr., Glenn H. Perkins, Millard G. Moore, and George P. Steinbauer. The Commissioner of Agriculture is the executive of the laws regulating the sale of foods, drugs, feeding stuffs, fertilizers, agricultural seeds, insecticides and fungicides in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to analyze or cause to be analyzed the samples collected by the Commissioner and to publish the results of the analyses together with the names of the persons from whom the samples were obtained and such additional information as may seem advisable. A brief summary of the results of the work of inspection is given in this report.

Food and Drug Inspection. The number and variety of samples collected and submitted for analyses depend upon the nature of the inspection work carried on by the Division of Inspections in the enforcement of the food and drug laws. Three hundred and thirty-one samples of foods, including Hamburg steak, ice cream, maple products, molasses, olive oil, vinegar and beef soup, and forty-seven samples of drugs, including citrate of magnesia, diluted hydrochloric acid, sweet spirit of nitre, tincture of iodine, aspirin, essence of peppermint, headache powders, and spirit of camphor were received. The results of the analyses on these samples are published in Official Inspections 155.

Several unofficial samples of milk, cream, vinegar, soil, and materials suspected of containing poison, were received from residents of the state. The results of the analyses on these samples are not published but are reported to the individuals who submit the samples to the Station.

Testing of Dairy Glassware. It is required by law that all Babcock glassware used in Maine by creameries, ice cream factoies or others buying or selling milk or cream on a basis of the butterfat content must be tested for accuracy at the Experiment Station. One thousand and ten pieces have been examined and one thousand and seven were passed.

Feeding Stuffs Inspection. One thousand and sixty-one samples of feeding stuffs were received and analyzed. The percentages of protein, fat, and fiber were determined on all samples of cereal and vegetable feeds and the percentages of protein and fat on all samples of animal products. The results of the analyses are reported in Official Inspections 156.

Fertilizer Inspection. Three hundred and eighty-seven samples of fertilizers were collected and submitted to the Station by the inspectors. Two hundred and sixty of these samples were mixed goods containing nitrogen, phosphoric acid, potash, and in some of the samples, magnesium. The samples of mixed goods collected and analyzed represent two hundred and seventeen different brands. The results of the analyses are published in Official Inspections 157.

Inspection of Agricultural Seeds, Insecticides and Fungicides. During the year 1935, ninety-five official samples of seeds were tested. Seedsmen and farmers sent in a total of one hundred and twelve samples for germination and purity tests, making a total of two hundred and seven samples tested during the year.

The samples submitted by the Division of Inspections included:

Alfalfa	2 samples	Mammoth clover	1 sample
Alsike clover	9 "	Oats	5 samples
Barley	3 "	Orchard grass	2 "
Bent grass	1 sample	Red clover	9 "
Bluegrass (Ky.)	2 samples	Redtop	14 "
Buckwheat (Jap.)	4 "	Rye grass	1 sample
Corn	2 "	Sudan grass	3 samples
Hungarian millet	9 "	Timothy	13 "
Japanese millet	9 "	Wheat	3 "
		White clover	3 "

Fifty-nine samples of insecticides and fungicides were received. The results of the analyses are reported in conjunction with the results of the examinations of agricultural seeds in Official Inspections 158.

Gasoline and Motor Oil Inspections. The State Tax Assessor is the executive of the law regulating the sale of motor gasoline and oils and the Maine Agricultural Experiment Station is required to make the analyses.

GASOLINE. One hundred and forty-four samples of gasoline were received and examined during 1935. Six of these samples were found to require a higher temperature for complete distillation than the maximum temperature (437° F.) specified in the law regulating the sale of motor gasoline.

MOTOR OIL. One hundred and seventy samples of motor oils were received and examined. Twenty-one of these samples failed to meet the specifications for the respective brands asked for by the inspector. In practically every instance it appeared to be a case of substitution by the salesman. A good quality oil of either a lighter or heavier grade than the one requested was supplied.

ANNOUNCEMENTS

Doctor James Monroe Bartlett died on May 11, 1935, having been continuously in the employ of the Station for 50 years. Doctor Bartlett was one of the three original appointees when the Station was organized in 1885. He began as an Assistant in the Department of Chemistry, later became Head of that Department, and had served, also, as Acting Director of the Station during several periods of the illness of former Director W. J. Morse.

Mr. Elmer Robert Tobey was appointed Head of the Department of Chemistry, the appointment effective June 1, 1935, to succeed Doctor James Monroe Bartlett. Mr. Tobey formerly had been Research Chemist for the Station. His new appointment requires that half his time be devoted to the Inspection Service.

Mr. Glenn Harold Perkins was appointed Assistant Chemist in the Inspections Service, appointment effective July 1, 1935. Mr. Perkins had been in the employ of this Department since October, 1931, as a temporary employee. He is a graduate of the University

of Maine, class of 1930, and received his Master's Degree from the same institution in 1931.

Mr. Millard George Moore was appointed Assistant Chemist in the Inspections Service, appointment effective July 15, 1935. Mr. Moore is a graduate of the University of Maine with the class of 1919. He was in the Inspections Service at the Geneva, New York, Station from 1919 to 1929, and with the Dupont people for 19 months doing research on synthetic urea. He received the Master's Degree at the University of Maine in 1931 and in 1932 was employed by this Station temporarily on research work.

Mr. Merle Tyson Hilborn was appointed Assistant in Plant Biology, appointment effective July 1, 1935. Mr. Hilborn was employed to take charge of a study of winter injury in apple trees. This study has been carried coöperatively by the State Department of Agriculture, the State Pomological Society, and the University.

PROJECTS FOR 1935

AGRICULTURAL ECONOMICS

An economic study of the dairy industry in Maine.
An economic study of the potato industry in Maine.
Local market conditions and requirements of agricultural products in Maine, Cumberland County.
Agricultural credit in Maine.
Agricultural adjustment and land use project.

BIOLOGY

The relation between shape and yield of apple trees.
Breeding new varieties of apples.
Nursery stock investigations and bud selection in relation to growth, yield, and color differences in the apple.
A study of the cause and possible control of "leaf scorch" of apple trees.
Causes of cross and self sterility in certain plants, particularly the apple, as determined through cytological and genetic study.
A study of picking date, effect of artificial preservatives, and other factors as related to problems of storage of Maine apple varieties.
To determine the cause of russeting of Golden Delicious apples and methods of preventing it.
A study of the fertilizer requirements of the native Maine blueberry.
Breeding investigations with the blueberry.
Blueberry field management.

Fruitfulness in the blueberry.
Weed control in blueberry fields.
Breeding investigations in canning crops with special reference to sweet corn and beans.
The mode of inheritance of milk production and associated characters in cattle.
The inheritance and nature of resistance to scab (*Cladosporium cucumerinum*) in *Cucumis sativus*.
Breeding and cultural investigations with garden crops.
Pasture improvement studies.
Fertilizer experiments with potatoes in rotation with grain and clover.
A study of clover failures in a potato rotation.
A study of various green manuring crops as a means of increasing and maintaining the organic matter content of potato soils in two, three, and four year rotations.
A study of soil conditions and other factors affecting development and control of potato scab.
A study of the physiology of reproduction in poultry.
Influence of anti-rachitic substances on growth in poultry.
The prevention of water heart in rutabagas, browning of cauliflower and other physiological troubles of *Brassica*.
Fertilizer experiments with sweet corn and beans in a four-year rotation—oats, clover, sweet corn and beans and with sweet corn in a two-year rotation—sweet corn and an annual green manuring crop (mixture of oats and peas).
Cytological studies in species crosses.
Small grain variety test including oats, barley, and wheat.
Investigations dealing with the production of leguminous hays in Maine.
The fertilizer and cultural requirements of small fruits.
The vitamin assay of Maine-grown fruits and vegetables.
Breeding investigation with small fruits, particularly the raspberry and strawberry.
To study the physiological causes of winter injury in raspberries.
A study of methods of improving fertility in orchard soils.

CHEMISTRY

INSPECTION

Inspection of feeding stuffs.
Inspection of fertilizers.
Inspection of foods and drugs.
Inspection of fungicides and insecticides.
Inspection of seeds.
Inspection of gasolines and oils.
Calibration of creamery glassware.
Inspection of milk and cream.
Miscellaneous analyses.

INVESTIGATION

Chemical analyses in connection with the problem of nutrition and growth of poultry and dairy cattle. (In coöperation with the Biology Department.)
Soil analyses investigation and analysis of materials used in connection with the permanent rotation and fertility experiments at Aroostook Farm. (In coöperation with the Biology Department.)
Miscellaneous analyses.

Entomology

Aphid investigations with special reference to the different food plants of migratory species.
A study of apple maggot problems, including dispersal.
Insects affecting the blueberry.
The cabbage maggot.
Control of the cabbage maggot.
Experiments with sodium and calcium fluosilicates in the control of the cucumber beetle and other insects.
Cutworms affecting field and garden crops.
Insects in relation to the transmission of virus diseases of potatoes.
Garden slug control.
Wireworms affecting field and garden crops.
The Mexican bean beetle.
The carrot rust fly.
A study of the potato flea beetle with special reference to its control.

Home Economics

The economic utilization of electricity in food preparation in Maine rural homes.
The factors affecting the cooking quality of potatoes.
A study of the financing by Maine families of the higher education of their children in Maine institutions.
Food habits and nutritional status of children in selected communities in Maine.
The effect of an improved diet upon the health and nutritive condition of grade school children in Mars Hill, Maine.
The antiscorbutic value of home canned pickles of various types used in Maine.

Plant Pathology

Apple scab control.
Blueberry diseases.
Cucurbit disease control.
Differentiation and dissemination of potato virus diseases.

Dusting and spraying potatoes.
Economic effects and control of potato virus diseases.
Histology and ecology of potato tuber rots.
Identification and dissemination of causes of potato rots.
Seed disinfection of potatoes.
Stem-end browning of potato tubers.
Epidemiology, economic effects and control of bacterial wilt (Stewart's disease) of corn.
Plant disease survey and miscellaneous diseases. Annual recording, through correspondence and observations, of the prevalence and severity of plant diseases, and preliminary experiments on miscellaneous diseases that develop importance.

PUBLICATIONS

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year make up the annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and may be bound with the annual report as an appendix thereto. Miscellaneous publications, consisting of newspaper notices of bulletins and newspaper articles which are not paged consecutively and for the most part are not included in the annual report, also are issued during the year.

BULLETINS ISSUED IN 1935

No. 378. A study of the organization and management of potato farms in Aroostook County, Maine. 80 pages.
No. 379. A study of the organization and management of potato farms in Central Maine. 58 pages.
No. 380. Summary Report of Progress 1935. 120 pages.

OFFICIAL INSPECTIONS ISSUED IN 1935

No. 155. Foods and Drugs. 20 pages.
No. 156. Commercial Feeding Stuffs, 1934-35. 54 pages.
No. 157. Commercial Fertilizers, 1935. 42 pages.
No. 158. Commercial Agricultural Seeds, 1935. Fungicides and Insecticides, 1935. 24 pages.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1935 BUT NOT INCLUDED IN THE BULLETINS

A complete list of all the Bulletins issued by and from the Station in 1935 is given on page 249 of this Report. The following pages contain abstracts of the papers published during the year and not included in the Bulletins or Official Inspections.

A STUDY OF INDIVIDUALITY IN THE NUTRITIVE INSTINCTS AND OF THE CAUSES AND EFFECTS OF VARIATIONS IN THE SELECTION OF FOOD*

This paper is a first report of studies on the nature of the nutritive instincts and on the causes and effects of variations in the selection of food. Many factors which effect the drive for food—genetical, physiological, psychological, and environmental—have been analyzed under controlled experimental conditions in the hope of uncovering those biological laws which lie beneath individual variation in the selection of food and reveal the nature of the adaptation of the individual to his nutritional environment.

For this purpose a new biological assay technic has been developed whereby a series of individuals differing quantitatively from each other are used as a shifting battery of testers for food requirements. This "individuated" assay technic, emphasizing individuality as it does, nevertheless, does not lose sight of the individual's relation to the group since the series of individual types together forms the group. Inferior individuals are as valuable as are superior individuals since each individual gains value in so far as he indicates nutritional deficiencies or excesses or points to the optimum conditions required by superior individuals.

This technic is in distinct contrast to the present day methods of conducting biological assays in which the experimental subjects are treated as average "groups" and the experimental rations are presented as "mixtures." With the individual disassociated from the group and therefore free, and with the foods presented not as a mixture but separate for free selection, the maximum freedom is

* This is an abstract of a paper by W. Franklin Dove, having the same title and published in Amer. Naturalist 69:469-544. 1935.

obtained and the nature of the interaction between the individual and his nutrient environment is clearly revealed.

On the basis of these experiments and inferences derived therefrom, the following working principles or laws of the nutritive instincts are here proposed:

I. The nutritive instincts, manifest in a choice of food, are measurable and distinctive characteristics of the individual with a consistency that indicates the existence of biological principles guiding their expression.

II. The expressions of the nutritive instincts *vary* from individual to individual—some individuals appear wise and others unwise (less wise) in their choice of food.

This fact contraindicates against the *group* technic of free-choice feeding recently recommended for both animals and children.

Choice of food is not entirely the result of experience and habit. In fact, the nutritive instincts are principally innate, "purposive" or directive reactions expressed with varying degrees of accuracy from the first contact with food and altered with the altered demands of the organism.

III. Variations in the nutritive instincts from individual to individual are due principally to innate differences. These innate differences may be accentuated or modified by imitation, limitation of opportunity and social adjustment, and may be stabilized by habit.

IV. Regardless of the origin or cause of individuality in expression of the nutritive instincts, the choice of nutrients varies in direct mathematical relation with the demands for bodily development and functional activity. This covariability between choice of nutrients and form or function may be expressed equationally, and when so expressed and reapplied to the feeding of groups of individuals genetically similar, may be used to modify that form or function within the limits of the phenotype.

Such an equational expression of choice of nutrients and genetic response may be used:

A. To determine the optimum nutritive requirements, both qualitative and quantitative, for a particular genotype—a mathematical expression of the interrelation between heredity and environment.

B. To determine the minimum and the maximum potential expression of the character resulting from the interaction of the specified genes with certain specified nutrients.

C. To constitute a technic:

(1) For the detection of causes of nutritional deficiency diseases, and the nutritional factors which contribute to longevity and other desired characteristics of the organism;

(2) For the biological assay of complex food substances;

(3) For the analysis of the complementary action of foods; and

(4) For the rationing of animals and men of different genotypes.

D. To discover the combination of nutrients best adapted to each new genotypic complex as it is modified through genetic selection or as it shifts naturally in the process of evolution.

E. Either to restrict or to stimulate development or function, and, as a consequence,

F. To transcend all known existing values in the controlled production of the infrabeast and the inframan as well as in the realization of the superbeast and the superman.

The foregoing laws may be applied as a general principle to all phenomena in which both a controllable individuality and a conditionability exist.

CLASSIFICATION OF CHICK-EMBRYO POSITIONS AT DIFFERENT AGES AND MALPOSITION AS A CAUSE OF MORTALITY*

A systematic classification of the positions taken by normal hatchable chick embryos and by the dead-in-shell shows that position as such is not always, and may only occasionally be, the real cause for failure to hatch. Position VI of Hutt and Cavers has been found to occur in hatchable chicks with a frequency equal to that found in dead-in-shell chicks; it cannot therefore be termed a malposition. Position III of Sanctuary and position V of Smith have been shown to be due to a delayed development taking effect prior to the fifteenth day of incubation. Defective embryos in new

* This is an abstract of a paper by W. Franklin Dove, having the same title and published in Jour. Agr. Res. 50:923-931. 1935.

positions have been associated with nutrition of the dam. Thus the correlation between position and embryo mortality is in part spurious. Postdiction of causes for failure to hatch from position of the embryo become apparent only after the conditions are resolved into more fundamental causes, i.e., effects of breeding, of feeding, and of incubation methods, many of which bring about a retardation in the normal shift in position as a secondary after-effect of the true lethal factor.

A position code is presented for the classification of embryos. It is based upon a combination of independent and mutually exclusive events so that the position of any embryo may be easily described by means of a four-letter code.

BREEDING CUCUMBERS RESISTANT TO SCAB*

One hundred and twenty-five progenies from self pollinated cucumber plants representing twenty-two varieties were tested for resistance to scab (*Cladosporium cucumerinum*). These were subjected when in the seedling stage to artificial inoculation by spraying with a spore suspension. Resistance was found in eight of the seedling populations. A genetic study of some of the material suggests that a single major factor is involved in the inheritance of the character. Accuracy of the method of testing for resistance in the seedling stage was demonstrated by comparing seedling response of numerous progenies with field behavior.

LARVAL PRODUCTION AND ADULT EMERGENCE OF THE APPLE FRUIT FLY IN RELATION TO APPLE VARIETIES†

This publication presents certain phases of the biology of the apple fruit fly revealed by investigations conducted at Highmoor Farm during the years 1931-1933.

The number of larvae emerging from large numbers of apples, all heavily infested, were found to vary according to variety. From Red Astrachan apples an average of 3.1 larvae per apple was ob-

* This is an abstract of a paper by R. M. Bailey and I. M. Burgess, published in Proc. Amer. Soc. for Hort. Sci. 32:474-476. 1934.

† This is an abstract of a paper by C. O. Dirks, having the same title and published in Jour. Econ. Ent. 28:198-203. 1935.

tained, and from Wealthy, an averge of 3.7; from Baldwin, however, an average of only 0.17 larvae per apple emerged. It was also found that the larvae begin emerging first from the early varieties, and later from slower maturing apples, the larvae being able to develop with increasing rapidity as the apples ripen. Larvae from Red Astrachan begin emerging early in August, and from Wealthy about three weeks, and from Baldwin about four weeks later. Larvae leave the Red Astrachan apples in greatest numbers during the last week in August, and the peak of emergence from Wealthy occurs about three weeks later. In the case of Baldwin apples no definite peak occurred, but larvae emerged in maximum numbers during late October and early November.

Most of the flies emerge during the first summer following the development of the larvae in the apples. A certain percentage of the insects may emerge, however, during the second or third summers. On the average, 28.45 per cent of the larvae emerged as flies during the first summer, and 1.61 per cent during the second summer, and less than 0.1 per cent during the third summer.

Flies emerged from areas exposed to full sunshine from 10 to 13 days earlier than from shaded areas. No consistent differences were observed in the time of emergence of flies produced from early apples, as compared to those produced from late apples.

A study of 39,000 flies, emerging during the three-year period, showed a total of 54.7 per cent females. During the first part of the emergence period the flies were predominantly female. As the emergence progressed, the proportion of males increased, until toward the end of the period, males predominated. At the time of maximum emergence, the numbers of males and females were about equal.

POTATO VIRUS DISEASES IN 1934*

From the 120 published articles appearing during the past year on potato virus diseases, our knowledge of these diseases has been increased with respect to their natural spread, their transmission by insects, their effects upon the potato plant and crop, their nature, and their control through tuber indexing, certification, se-

* This is an abstract of a literature review by Donald Folsom, having the same title and published in the Amer. Potato Jour. 12:304-310. 1935.

lection, and seed-plot methods. Aside from the resistance of certain potato varieties, no completely effective method of control has been discovered except protection by insect-proof cages or greenhouses. The German theory that potato degeneration is caused only by poor growing conditions is being corrected in Germany by experiments which finally have been begun there on virus diseases. The list of virus diseases attacking the potato has received three additions.

METEOROLOGICAL OBSERVATIONS

The Station is indebted to the Department of Physics of the University for the meteorological summary for 1935 which appears on the following page.

The instruments used are located on the University campus at Lat. 44° 54′ 2″ N., Long. 68° 40′ 5″ W., Elevation 135 feet. They are the same as those used in preceding years and include; maximum and minimum thermometers, rain gauge, self-recording anemometer, vane, and barometers. The observations at Orono now form an almost unbroken record of sixty-seven years.

METEOROLOGICAL SUMMARY FOR 1935
U. of M. Orono, Maine

1935	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	42	50	60	81	89	90	95	104	84	76	64	46	-------	-------
Lowest temperature	–27	–20	–4	20	31	42	46	45	30	24	16	–6	-------	-------
Mean temperature	12.38	17.36	31.35	44.09	53.25	62.55	72.43	69.25	56.53	47.98	38.81	21.45	43.95	-------
Mean temperature in 67 years	16.46	19.01	30.15	39.43	51.04	61.30	67.23	65.75	60.13	49.18	37.13	22.98	43.32	-------
Total precipitation in inches	8.54	1.69	1.96	2.87	1.36	4.46	2.25	2.05	2.44	1.16	5.04	1.82	-------	35.64
Mean total precipitation in 67 years	3.93	4.14	3.62	2.86	3.25	3.46	3.43	3.43	3.48	3.92	3.53	3.52	-------	42.57
Number of days with .01 inch precipitation or more	11	8	7	9	11	11	9	9	6	4	10	6	-------	101
Snowfall in inches	45	16	8	2.5	-------	-------	-------	-------	-------	-------	2	8	-------	81.25
Mean snowfall in 67 years	21.55	21.17	13.64	5.37	-------	-------	-------	-------	-------	.70	5.87	15.26	-------	83.56
Number of clear days	13	16	22	18	15	13	19	19	15	17	5	12	-------	184
Number of partly cloudy days	4	5	2	4	10	8	7	5	9	9	7	7	-------	77
Number of cloudy days	14	7	7	8	6	9	5	7	6	5	18	12	-------	104
Average wind velocity in miles per hour	3.83	3.89	4.59	4.57	4.71	3.88	3.99	3.79	3.50	4.04	5.19	3.73	4.14	-------

REPORT OF THE FINANCES OF THE STATION

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts may be audited by the State Auditor, and the Hatch Fund, Adams Fund, and Purnell Fund accounts are also audited by the Office of Experiment Stations acting for the Secretary of Agriculture of the United States in accordance with federal law.

The income of the Station from federal and state appropriations for the year that ended June 30, 1935, was:

U. S. Government, Hatch Fund	$15,000.00
U. S. Government, Adams Fund	15,000.00
U. S. Government, Purnell Fund	60,000.00
State of Maine, Mill Tax, Other Income, Sales, etc.	35,233.27
State Department of Agriculture	14,360.74
Total Income	$139,594.01

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experimental farms and the poultry plant is used for the expense of investigations. The cost of printing the Station bulletins is paid by the University from funds other than those mentioned above.

At Aroostook Farm there are in connection with the coöperative work with the Federal Department of Agriculture certain expenditures for the Department made from sales of crops from Department investigations. These expenditures are not included in the tabular statements. They are carried as distinct and separate accounts, always with credit balances on the Station ledger.

REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1935

DISBURSEMENTS

	Federal Funds			State Funds		Total
	Hatch	Adams	Purnell	Mill Tax, Other Income, Sales, etc.	Inspections	
Personal Services						
Salaries	$ 8,562.33	$15,000.00	$43,167.62	$ 7,163.47	$ 9,988.46	$ 83,881.88
Labor	1,191.84		7,852.16	12,614.02	2,381.33	24,039.35
Supplies and Materials						
Stationery and office supplies	251.36		191.70	194.25	10.00	647.31
Scientific supplies, consumable	304.34		323.66	1,014.08	533.64	2,175.72
Feeding stuffs	372.13		1,998.26	992.32		3,362.71
Fertilizers	6.67		23.99	1,770.32		1,800.98
Sundry supplies	304.20		710.87	1,666.74	25.06	2,706.87
Communication Service	266.72		62.07	263.51	44.21	636.51
Travel Expenses	871.59		2,607.35	2,794.04	143.40	6,416.38
Transportation of Things	73.90		69.12	273.45	109.91	526.38
Printing and Illustration Publications	7.50		22.55	12.00		42.05
Heat, Light, Water, and Power	1,686.30		860.45	3,259.95	538.84	6,345.54
Contingent	41.83		35.45	317.07	5.00	399.35
Equipment						
Furniture, furnishings, and fixtures	13.89		219.55	380.51	91.37	705.32
Library	710.95		35.19	149.14	8.00	903.28
Scientific equipment	134.61		621.69	648.21	453.16	1,857.67
Tools, machinery, and appliances	75.51		640.56	2,227.29		2,943.36
Livestock	34.85		277.20	668.90		980.95
Buildings and Land	89.48		280.56	1,750.32	28.36	2,148.72
Total	$15,000.00	$15,000.00	$60,000.00	$38,159.59	$14,360.74	$142,520.33